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NEW YORK, FEBRUARY, 1893.

A CORRECTION.

OWING to the mistake of a photographer, the scale of the engraving of the New York Central locomotive No. 903, which was published last month, was not the same as that of the English engine illustrated with it. This was discovered last month too late to be corrected. We have, therefore, had the former re-engraved, and reprint both of them. Copies of the reprint will accompany the present (February) number. Both engravings are now made to a scale of $\frac{1}{4}$ in. = 1 ft., and therefore show the relative size of the two engines. Those of our readers who preserve their papers should substitute the folded plate with this number of the JOURNAL for the one attached to the January number.

EDITORIAL NOTES.

THE next article in the series on Practical Railroad Information is necessarily postponed until next month; but the authors expect hereafter to continue this valuable serie without a break.

THE convention of the National League for Good Roads, held recently in Washington, was largely attended. It was decided to apply to Congress for a charter, and to ask for an appropriation to enable the Department of Agriculture to make a general inquiry into the condition of the roads of the country.

THE Executive Committee of the Master Mechanics' Association urges upon railroad officers the advantages to be gained by giving more attention to the standards of the Association and by following them in giving orders for rolling stock. Especial attention is called to the standard screw-threads and the sizes of wheel centers and tires.

As noted in another column, the Joint Committee of the Master Mechanics' and the Master Car-Builders' Associations has decided to hold the conventions next summer at Lakewood, N. Y., on Chautauqua Lake. There is said to be ample hotel accommodation there, and all the facilities required for the meetings.

THE recent collision in the Japan Sea between the packet steamer *Ravenna* and the Japanese cruiser *Chishima-Kan* may throw some light on the possible results of ramming in a naval fight. The *Ravenna* struck the cruiser amidships, cutting her nearly in two, and had all the advantages of position which a ram could desire; but she suffered severely herself, the *Chishima-Kan's* protective deck cutting through her stem and bow plates for nearly 10 ft., and smashing in the bow so that the ship was kept afloat with great difficulty. It is evident that in a ramming contest the risk is not all on the side of the vessel attacked; the ram itself will run no small risk.

THE readers of Mr. Chanute's earlier papers on Aerial Navigation will remember an account of the balloon *La France*, with which some interesting experiments were made in 1884–85. We are now informed by *La Nature* that a balloon on the same general lines as *La France*, but longer, is being built at the French military balloon works at Chalais-Meudon, under the direction of Commandant Renard. The new balloon, as described in *La Nature*, is 230 ft. long and 43 ft. in diameter at the center. The car is provided with a screw in front and a rudder behind and carries a gasoline motor. This motor is not fully described, but it is stated that it will exert an effective force of 45 H.P. on the shaft, and that its total weight, including a tank filled with gasoline, is about 66 lbs. per horse power. Making 200 revolutions per minute of the screw, it is calculated that the air ship will make headway against air currents not exceeding 40 ft. per second, or about 27 miles an hour.

The new balloon is to be ready for experimental use early in the spring.

THE franchise offered for sale by the New York Rapid Transit Commission for building the underground line proposed by the Commission was not sold, only a single bidder appearing. His bid was not considered, as he only offered $1,000, and it did not appear that he was a responsible person. The result was generally anticipated.

The Commission is now considering applications for branches and extensions of the lines of the existing elevated road. One of the latter follows nearly the line laid down for an underground road.

ENGINEERS AND ARCHITECTS.

THE *American Architect and Building News*, in commenting on a proposition of one of its contemporaries, that architecture and engineering ought to be united, or, rather, ought never to have been divorced from their ancient union, remarks;

To a certain extent this is reasonable, and architects ought to be and, we think, generally are, as familiar as engineers with the scientific principles of construction; but that they can with advantage treat their problems as an engineer does his is altogether too much to say. . . . In nine tenths of the engineering work of the present day the problem set before the designer is simply to get the strength required to resist dead-load, live-load, wind pressure and thrust, with the smallest possible expenditure of material and labor. In fact, nearly all structural engineering work is designed by or for contractors, who bid for the job in accordance with the designs they sub-

mit, and the one who has succeeded in "skinning" his project down to the lowest possible cost gets the contract. It is obvious that this sort of design is entirely unsuited to the temper and training which an architect should possess. (A good many of their clients have found this out.) It is one thing to study construction as the mediæval architects studied it, keeping beautiful effects always in their minds and using every new method of balancing pressures as a fresh artistic motive, and quite another thing to design a building with a sole view to straddling the space in the cheapest possible manner, without wasting a moment in considering the proportions of voids, spacing of horizontals, pitch of roofs, and the other considerations which take up so much of the architect's attention.

It must have been in this poetical spirit that the editor of the *American Architect* undertook to discuss the engineering subject of air ships, and tried to show how he could "straddle a space" without "wasting a moment in considering the proportions of voids." Here is the way he would do it: "It would be very easy, by using cylinders of compressed gas, to raise our air ship to the height required to launch it, and it ought not to be difficult to regulate the speed of the descent, by varying the position of the wings or by a horizontal rudder."

This principle evidently can have an extended application. In climbing mountains all a man need do is to carry a "cylinder of compressed gas" in each pocket to raise himself up hill; or, as tall buildings are now very much in vogue, cylinders of compressed gas might be substituted for elevators; and, as they say in patent specifications, other applications of the principle will suggest themselves, if "we only use every new method of balancing pressures as a fresh artistic motive to help us to straddle space."

In this case an architect "might with advantage have treated this problem as an engineer does his." If he had it would have appeared that coal gas, if compressed to about $\frac{1}{15}$ its volume, at atmospheric pressure, will be as heavy as air; and pure hydrogen, if compressed to $\frac{1}{14}$ its volume, would also be as heavy, so that it is hard to see how, in that condition, it would lift a balloon or anything else.

LOCOMOTIVE AND TENDER CONNECTIONS.

A COMMITTEE appointed at the last meeting of the Master Mechanics' Association, to make a report on "Attachments between Engines and Tenders," have recently issued their circular of inquiry. The questions they ask are a gratifying indication that the welfare and safety of the men who are engaged in the dangerous occupation of running locomotives is at least not entirely lost sight of by the members of the Association referred to, many of whom have, at some time or other, been locomotive runners or firemen themselves. It is not necessary to quote statistics to show that running locomotives is a dangerous occupation. That it is so is well known, but the relative amount of danger arising from different features of construction of locomotives has never been clearly shown. Probably more men are killed and injured by being caught and crushed between their engines and tenders in cases of collision and derailment than in any other way. This class of accidents until quite recently seems to have been regarded as unpreventable and incapable of diminution. The circular of the Committee referred to indicates that at least some of those who prepared the circular are disposed to think that something could be done to mitigate this source of risk to which men on locomotives are exposed. The first question of the circular is as follows:

1. With engines coupled to tenders by a single stout link and large pins so strong as not to break loose under the heaviest pull, have the tank-frames any marked tendency to either mount or run under the cab foot-plates? In other words, is there any more risk from the tender-frame than there is from the tank leaving the frame and sliding into the cab?

In view of the fact that there are a great many members of the Master Mechanics' Association who are able to say definitely from their own observation or experience whither, in cases of accidents, tender frames *do* "mount or run under the cab foot-plates," it would seem to be idle to argue about a "tendency." If the Committee had asked the question whether members have known of tender frames mounting or running under the foot-plate in cases of collision or derailment, and they would answer the question, it is believed that an abundance of testimony would have been elicited to show that that occurs very often. An ordinary draw-bar between a locomotive and tender is usually about 4 ft. long from center to center of pins, and is often bent so that the middle portion stands at a greater or lesser angle to a horizontal line. Owing to the inclined position of the bar the "tendency," in case of a severe collision, is to push its front end upward and carry the foot-plate and back end of the engine with it, and to depress the back end of the bar and the tender, thus facilitating the running under of the latter. The concussion thus exerts a downward force on the back end of the draw-bar, and an upward force on its front end. These forces, being exerted on the ends of the bar, act with a leverage equal to its length on the castings to which it is coupled, tending to pry open the pockets which receive the ends of the bar. Considering the force of a collision, the length and size of the bar, the leverage with which the force is exerted, and the comparative weakness of the castings and bar, it is evident that, under these conditions, they would offer little effective resistance to prevent the engine and tender from "mounting."

In case of collision the position which the engine and tender will assume is of course very uncertain. The front end of the engine may be raised up and the back end depressed so as to facilitate the mounting of the tender on the foot-board. All that we want to point out here is that the draw-bar does not give adequate protection to prevent such accidents.

The second and third questions of the circular are:

2. If tender-frames have such a tendency, can it be prevented? If so, is the probable expense, weight and work required to prevent it in your opinion justified?
3. If you are not using such a device, are you familiar with any fastening, equipment or invention that is designed to prevent tender-frames from mounting? If so, will you illustrate or describe it?

It is claimed for the vestibule system that it effectually prevents cars from telescoping. When this occurs, the floor timbers of one car always mount on top of the platform of the other. This to a certain extent would be prevented by the construction of the vestibule. A proposition to put vestibules between engines and tenders, even though they did save life, would probably not meet with much favor with railroad managers. Another arrangement which has been devised for preventing the telescoping of cars, and which has been in use for many years on the Chicago & Alton Railroad, is the Blackstone platform, a diagrammatic side view and plan of which is shown in figs. 1 and 2, and which has heretofore been illustrated and commended in these pages. The principle of this, it would seem, could be readily applied to the connection of engines and tenders. The peculiar feature of the platform is shown in the two views. At each end of the cars two safety-beams, *a a*,

a' a' and *b b*, *b' b'*, which project beyond the buffer-beams, are fastened below the floor sills. The safety-beams are not placed at equal distances from the center of the car, but one is further from it than the other, so that when one car adjoins the other, as shown in the plan, fig. 2, the safety-beams interlock with each other as shown. It will also be seen that

Fig. 1.

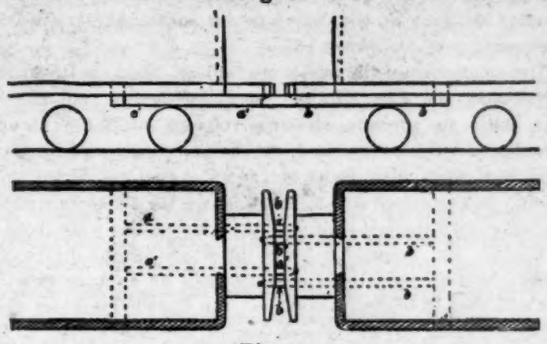


Fig. 2.

those on the one car project under the buffer-beam of the other, so that the one car cannot raise up or be depressed without taking the other with it. In this way the floors are kept in line, and the longitudinal beams which form the car frames must resist the shock of collision.

If applied to locomotives and tenders, the beams, instead of being made of wood, might be of iron, and might be made in the form of hooks similar to a letter L, the vertical part being fastened to the end of the engine or tender frame, and the horizontal portion would then project under the adjoining frame to the one to which the beam is attached. In fact, projections might be forged on or bolted to the back ends of the engine frame which would project below the tender frame. The expense of such an arrangement would be very slight, and would save many a poor fellow from death or injury and unspeakable suffering. Who will be the first to give it a trial?

Before this is done, a few words of objurgation may do some good. There is a curious tendency in human nature to be penurious. This tendency is not confined to money, or what can be represented by dollars and cents. Many people are penurious in quantities, which are not convertible into dollars and cents—they will be stingy in feet and inches, in pounds and gallons, when these have no value. The unwillingness of an ordinary mechanic to give ample bearing surface to journals and other mechanical structures is an illustration of what we mean. The inadequate supply of air in the ventilation of cars and houses is another. It took many years of exposure and many disastrous accidents before engineers overcame this kind of penuriousness and built bridges and steam boilers of ample strength to resist the strains to which they are subjected. The advice often quoted in these pages, "If you must make a thing strong, make it profanely strong," expresses resentment to this kind of meanness.

Now, if any one should undertake to apply the principle of Mr. Blackstone's platform to engines and tenders, for the protection of the men who run them, it is hoped that he will remember that the safety of human lives and limbs will be dependent on the strength of these appliances, and therefore a very large factor of safety should be allowed.

The Committee have also taken up the subject of footsteps and hand-rails for locomotives and tenders, and ask the following questions:

Are long steps safer or more advantageous than short steps having good, high flanges to prevent the side movement of the foot after it has once touched the step?

Are there any materials for steps (or the working faces of steps) safer and better, in all states of weather and greasiness, than roughened iron?

If so, what are the qualities they possess? Illustrate or describe the manufacture, shape and size, saying how the material is used.

Should side steps on engine and tender be the same height—that is, in line the one with the other?

What is the best height from top of track tie to working face of step? Would increasing the number of steps and lessening the vertical height (or the riser) in your estimation add to the safety of the men?

Are the long, upright handles safer and more effective than short handles?

Is there any usefulness in long, horizontal hand-rails on tank?

Are low hand-rails and foot-steps desirable at the front end of any engine equipped with a pilot?

If any improvement in hand-rails or foot-steps is desirable on yard engines, should not road engines be similarly equipped, both for safety and uniformity?

The replies of master mechanics, and, if it were possible to get them, answers from experienced locomotive engineers, to these inquiries would be very interesting. Considering the danger to which these men are exposed, the subjects on which the Committee are to report have never received the attention which they should. We have no data at hand to show the number of engineers and firemen who are killed or injured annually in this country, but it must be very large. The attending suffering is inconceivable, and the distress which is a consequence of such accidents is incalculable. From motives of humanity, then, the Committee should give the subject all the attention possible, and the Association will incur a grave responsibility if they fail to take action on any measures presented for their consideration which would give greater safety to the men who are now exposed to so much danger.

It is a matter, too, which would be a very proper one for the Brotherhood of Locomotive Engineers to take up. There are now no statistics which show clearly the exact causes of accidents to locomotive engineers and firemen. If the Brotherhood should take action, requiring each division to appoint a committee, whenever an engineer or fireman was disabled from an accident, to report the extent of his injuries, with a brief statement of how the accident occurred and the causes of it, and if these reports were published monthly or quarterly, so that they could be tabulated and analyzed, they would be sure to indicate the most prolific causes of such accidents and point out how, or at least the direction in which measures should be taken to prevent them.

RECENT INVENTIONS IN ARMOR.

THE files of the Patent Office, even at this late day of armor development, show many curious devices in the way of armor construction, and remind one of the early days when wire rope, rubber in all sorts of combination with iron, compressed wool, hogs' hair, etc., were brought forward by sanguine inventors to match artillery projectiles.

Two recent patents for armor plate possess at least the quality of novelty—the one covering a method of constructing and applying the plate to a ship's side; the other a device for face-hardening or carbonizing it during the process of casting.

The "Henry Clay improved armor plate" is double—a thick plate attached to a ship's side in the ordinary way, while in front of it is suspended a thinner face plate. This latter

is provided with projections or pistons which fit into corresponding recesses in the under plate, with the expectation, as the inventor says, that the air chambers thus formed will, "upon a blow of a projectile striking the outer or exposed plate, serve as cushions, whereby the force or impact of the blow is, as stated, absorbed, and the penetration of the plate by the projectile prevented." A series of elliptical springs between the plates hold them apart, so that the pistons barely enter the corresponding recesses.

Without considering any of the mechanical difficulties in the way of successfully constructing and applying armor plate as thus proposed, or its necessarily great cost, it may be said in advance of experiment that there is no likelihood of its behaving in any such way as expected by the inventor. Matched against a spherical projectile moving with a low velocity, it is quite possible that something might be gained in resisting power by a plate so constructed. As against a projectile from a modern rifle, with a velocity of 2,000 ft. or more per second, it is safe to predict that before the outer plate could bring up its reserves of elasticity stored in the chambers under the pistons, the projectile would be through this outer barrier uninjured and ready to do its work upon the softer plate beneath. Particular reference to this plate has been made for the reason that it is constructed upon a theory that every armor-plate experiment since the advent of the high-power rifle has proved to be erroneous—a theory to which all the advocates of compound armor are wedded. The fact above all others that recent armor trials have demonstrated is that no quality in the substructure of an armor plate, be it elasticity, ductility, or strength to resist rupture, can compensate for the lack of sufficient face hardness to break up or throw off the shot. In other words, the outer barrier must of itself be equal to stopping the projectile if it is to be stopped at all; there is no time, so to speak, to call up reinforcements or fall back upon reserves.

Under the title of an "Improvement in the Process of Casting Armor," Messrs. Chase & Gantt propose to secure face hardness by constructing the mold walls wholly or in part of manganese, silicon or other fusible material with which the steel will alloy. The walls of the mold will, it is claimed, when brought in contact with the molten metal, combine and alloy with the steel, hardening the surface thereof, the hardness diminishing toward the interior.

If by the use of such molds a sufficient and uniform degree of hardness can be obtained, it can hardly be doubted that a step in advance has been made in the methods of casting steel for armor plates, especially as plates thus cast may be further improved by forging or rolling, oil-tempering, and similar processes.

THE OCHTA ARMOR TRIAL.

THE recent armor trials at Ochta, Russia, have scored another victory for the American or Harvey method of treating armor-plate. This trial is particularly noteworthy as testing the relative merits of the Harvey and Tresidder processes of armor-making upon the same trial ground. Much was expected from the latter plate, and it was considered by many as the most formidable rival of the American plate in the field. In both systems the aim is to give the plate sufficient face-hardness to break up projectiles and prevent penetration.

The Harvey plate, as is well known, is of mild nickel steel, face-hardened by carbonization. In the Tresidder process this face hardness is given by subjecting the heated plate, which may be all steel or compound, to the action of a cold-water douche. The Harvey plate used in this trial was made in England by the Messrs. Vickers; the Tresidder plate, which was a Brown (Ellis) compound, by John Brown & Company, of Sheffield.

In this trial five plates were tested—two Cammell all steel, one of hard and the other of soft steel; a nickel-steel Schneider (French); and an American Harveyized nickel-steel plate. The trial of the first four plates mentioned took place on November 23; that of the last was, for some unknown reason, postponed until December 13.

The conditions of the trial were: Plate, 10 in. in thickness; projectiles, six 6-in. Holtzer steel, weighing 90 English lbs., with an average striking velocity of 2,178 ft. per second. Briefly summarized, on the first day's trial the Cammell hard steel plate went to pieces at the end of the third round; the Cammell soft steel withstood the six shots without cracking until the last shot, but the penetrations were from 12 to 21½ in.; the Schneider plate threw off all the projectiles either intact or partially broken up, with an average penetration of about 12 in. and no cracks; the Brown-Tresidder plate began breaking up at the first round, and was ruined at the end of the fifth, breaking up all of the projectiles. At the end of this day's trial the French plate was far ahead of any of its rivals.

On the second day's trial the Harvey plate, after throwing off four projectiles without cracking, and with only slight penetrations, was attacked with two 9-in. 400-lbs. shot, the first of which started a number of cracks and the last broke off a lower corner of the plate, but leaving the backing uninjured.

The victory for the Harvey plate was complete and unquestioned. The result showed great face hardness without brittleness, a combination of qualities difficult to obtain, and which approaches more nearly the ideal armor-plate than anything ever before brought to the trial ground.

THE PARISIAN INVENTORS' ACADEMY.

THAT there are a considerable number of scalawags in Paris is shown by the recent revelations of transactions in connection with Panama Canal affairs. That there are still more of the same genus besides those who helped to swindle the stockholders of that great scheme is shown by the following proposition just received by the editor of this paper:

PARIS, 15 *Faubourg Montmartre*,
the 6 of Janvier, 1893.

MATTHIAS FORNEY, ESQ.:

Sir: We beg to inform you that after the examination of your last invention the Parisian Inventors' Academy has conferred upon you the title of MEMBER OF HONOUR (*membre d'honneur*) *with award of the first class Diploma & the Great gold medal.* (*Plated*)

This honorable title will be of no expense to you, but if you are desirous to receive the Medal and Diploma, you would have to send us a Post money order of ten dollars (or currency per registered letter) to cover admission taxes freight, etc., and we shall send both well packed and free of charge to your address.

Trusting that our invitation will be favorably received, we are at your disposition in *Invention and Patent maters* according to the Academy which are enclosed, and

We remain, Sir, Your obedient servant

E. BŒTTCHER,
President.

The editor of this paper has not hastened to send a "Post money order of ten dollars" in response to the above, although he must confess that he felt flattered at having received so distinguished a title for so modest an invention as an improvement on car seats. He is somewhat like the man who received a present of Limburger cheese, and who acknowledged its receipt by writing that he "never knew anything to taste so good that smelt so bad." The editorial "WE" of this paper

makes the request publicly that *after* he receives the "Great gold medal (Plated)" that all correspondents address him with his full title of "*membre d'honneur*," and he will then seek for admission into a lunatic asylum.

NEW PUBLICATIONS.

PROCEEDINGS OF THE TWENTY-THIRD ANNUAL CONVENTION OF THE MASTER CAR & LOCOMOTIVE PAINTERS' ASSOCIATION OF THE UNITED STATES AND CANADA: HELD AT DETROIT, SEPTEMBER 14, 15 AND 16, 1892. *Corrected and Approved by the Secretary.* Philadelphia; published for the Association by the *House Painting and Decorating* Publishing Company.

The Association, whose annual convention is reported in this handsomely bound and printed volume, has done much good work during the term of its existence, and the present report shows that its activity does not diminish with age. The report contains some excellent papers and records of experience and of tests and experiments made; and many of the discussions are pointed and sharp, giving accounts of individual experience which may serve as valuable guides to other workers in the same line.

POOR'S HAND-BOOK OF INVESTMENT SECURITIES. THIRD ANNUAL NUMBER, 1892-93. New York; H. V. & H. W. Poor, No. 70 Wall Street.

This volume makes its appearance this year in greatly enlarged form, having 986 pages, or about twice the number of last year. This implies an increase of the ground covered, as well as greater completeness in the work, and the publishers evidently intend that the book shall completely occupy the field. Besides railroad securities it has lists of State, county and municipal issues; banks and a large number of industrial corporations are also included in the lists.

Besides lists of securities and information as to stocks and debts of the various corporations, the *Hand-book* gives statements of the dividends paid; location of transfer offices and agencies; time and place of annual meetings, and other particulars which it may be serviceable for an investor to know. Tables showing the range of prices at the New York Exchange and at those of other leading cities are also given, and in fact almost all the information which can be collected and given in a condensed form, and which bears on the present or prospective value of a security.

CURRENT READING.

AMONG the books announced as in preparation by Messrs. John Wiley & Sons is a PRACTICAL TREATISE ON FOUNDATIONS, by W. W. Patton, which will soon be ready.

The December number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE is an excellent one, with much good reading in it. There are articles on Mars; the Panamint Indians of the Mojave Desert; the Republic of Honduras; Longitude and Time; Antarctic Exploration; Influence of Rainfall on Commercial Development; and several other topics, besides the usual editorial departments. None of the articles are long, and all are readable.

The JOURNAL OF POLITICAL ECONOMY is a new quarterly, issued from the University of Chicago. The first number has papers on the Study of Political Economy in the United States, by J. Laurence Laughlin; the Recent Commercial Policy of France, by Emile Levasseur; Rodbertus' Socialism, by E. B. Andrews; the Price of Wheat since 1867, by T. B. Veblen; Notes, by Edward Atkinson and others; and book reviews. This table of contents will give an idea of the general scope and objects of the new review, which is addressed to thinking men and deserves to succeed—as we certainly hope it will.

The JOURNAL of the Military Service Institution for January has a continuation of General Tidball's interesting papers on Artillery Service in the Rebellion. Other articles are on Hot Air Balloons, by Captain Zalinski; Military Specialists, by Captain Hess; the Knapsack, by Captain Quinton; Musketry Training, by Captain Parker; Place of the Medical Department in the Army, by Lieutenant Williams; and several excellent translations and reprints.

The January number of the ECLECTIC MAGAZINE opens with an article on the Ruin of the American Farmer, from the *Nineteenth Century*. Other articles are from the *Fortnightly Review*, *Macmillan's Magazine*, the *Spectator*, *Blackwood's Magazine*, the *Contemporary Review*, the *National Review*, *Temple Bar* and the *Cornhill Magazine*, presenting an interesting selection of current English literature.

The February number of OUTING is fully up to the usual standard, and continues with undiminished zeal to preach the gospel of healthy exercise and open-air sport.

In the OVERLAND MONTHLY for February there are illustrated articles on the Digger Indians of 30 Years Ago; Santa Barbara in January; Life in the Napa Insane Asylum; and Football in California. Several shorter articles help to make up a very interesting number.

The February number of GODEY'S MAGAZINE, besides a complete novel by Edgar Fawcett, has several good articles, including one on the growth of the Chautauqua Idea, by George E. Vincent, and one on Mont St. Michel in Brittany. The several departments and the fashion plates will be welcome to engineers' wives and daughters, if hardly of deep interest to the engineers themselves.

The January number of the ENGINEERING MAGAZINE has articles on the Outlook for Foreign Markets; Industrial Development of the South; Geology and the Mississippi Problem; the Anthracite Coal Industry; Fire Losses and the Age of Clay; the True Cause of Labor Troubles; the Pan-American Railroad Surveys; Liquid Fuel in Steam Making; and the usual special editorial departments, which are full of interesting notes in this number.

The February number of SCRIBNER'S MAGAZINE has articles on travel in the Tyrol; on Tangier; on Florentine Artists; and a variety of interesting sketches, with some excellent fiction for those who enjoy light reading.

The series of articles on the Development of American Industries since Columbus will be resumed in the POPULAR SCIENCE MONTHLY for February, with an opening paper on the Glass Industry, by Professor C. Hanford Henderson, in which the history of glass-making during colonial times is traced. Among the other articles are included one on the Marine Biological Observatory at Wood's Holl, by Professor C. O. Whitman, and one on Ghost Worship and Tree Worship, by Grant Allen.

The February number of HARPER'S MAGAZINE contains a number of handsomely illustrated articles, including several of special interest.

The ARENA for February continues the work of discussing important topics as fully and carefully as usual. All thoughtful readers should see the list of subjects and writers already secured for this magazine during the current year.

The recent numbers of HARPER'S WEEKLY continue the work of illustrating the Columbian Exposition building. Among other notable articles recently have been those on the Capital Cities of the World; Brussels is the latest, and both text and engravings are excellent.

The February number of the NORTH AMERICAN REVIEW

has a list of articles well worth reading. This magazine is one that can hardly be passed over by those readers who want to be posted on the questions of the day.

The fifth number of the JOURNAL OF THE UNITED STATES ARTILLERY is chiefly given up to the discussion of rapid-fire guns, the claims of the Krupp, the Canet and the Schneider types being presented by different authors, while the questions raised are summed up in a concluding article.

BOOKS RECEIVED.

Sixth Annual Report of the Interstate Commerce Commission: December 1, 1892. Washington; Government Printing Office. Some references to this report will be found in another column.

Transactions of the Technical Society of the Pacific Coast: Volume IX, Number 11. San Francisco; published by the Society.

Report of the Chief of the Bureau of Medicine and Surgery to the Secretary of the Navy: 1892. Surgeon-General John Mills Browne, U.S.N., Chief of Bureau. Washington; Government Printing Office.

Annual Report of the Chief of the Bureau of Statistics, Treasury Department, upon the Foreign Commerce of the United States for the Year ending June 30, 1892. S. G. Brock, Chief of Bureau. Washington; Government Printing Office.

Massachusetts Institute of Technology: Department of Civil Engineering. Prospectus and Programme for 1893. Bostoh, Mass.; published by the Institute.

Duty Trial of a Fly-wheel, High-duty, Automatic Cut-off, Cross-compound, Pumping Engine, designed and built by the George F. Blake Manufacturing Company. New York; published by the Company.

Report to the Railroad Commission of California upon Just and Equitable Rates of Freights and Fares for the Railroads of California. By Richard Price Morgan.

Atmospheric Resistance and its Relations to the Speed of Railroad Trains; with an Improved System of Heating and Ventilating Cars. By Frederick U. Adams. Chicago; published by the Author.

TRADE CATALOGUES.

THE present year does not seem to be a good one for *Calendars*, of which a smaller number have been received than usual. A very neat one for the pocket, including a calendar for the year and a memorandum page for each day in the week, is issued by the *New York Equipment Company.* One of the neatest of the monthly calendars is that sent out by Mr. *Robert A. Keasbey*, bearing a very modest advertisement of his well-known magnesia sectional covering on its outer case.

Illustrated Catalogue and Price-list of the Athol Machine Company and the Standard Tool Company. The Athol Machine Company, Selling Agents, Athol, Mass.

This catalogue shows a great variety of vises, squares, gauges, calipers, levels, wrenches and other tools which the machinist finds necessary in his work. It is well illustrated and the prices are given in every case—a great convenience in a catalogue of this kind. Every mechanic who wants to do good work and to have the best tools to do it with ought to have a copy of this catalogue.

To the Roadmasters of America: A Souvenir. The Bush Cattle Guard Company, Kalamazoo, Mich.

This very pretty pamphlet contains a number of illustrations of the recent trip through the South made by the members of the Roadmasters' Association of America. It is well printed and bound, and the roadmasters who receive it will doubtless appreciate it fully—as well as the thoughtfulness of the Bush Cattle Guard Company in providing it.

Improved Hydraulic Jacks; Screw and Lever Jacks. The W. & S. Hydraulic Machinery Works, Watson & Stillman, Proprietors, Nos. 204–210 *East* 43*d Street, New York. Illustrated.*

This price-list gives descriptions and illustrations of a number of hydraulic jacks designed for general use and for special purposes; also of several patterns of screw-jacks, of a screw hoist and a tube expander made at the well-known works from which it is issued. Some directions for the proper use and care of hydraulic jacks and for their repair are also given, making it a useful and convenient pamphlet.

Consolidated Car-Heating Company. Part II, Sewall Steam Coupler, and Part III, Improved (McElroy) Commingler. Albany, N. Y.

Part II of the Consolidated Car-Heating Company's catalogue begins with a description and illustration of the Sewall steam coupler for connecting the flexible hose which is used between cars in heating them by this company's system with steam taken from the locomotive. A list of railroads using this coupler is then given, which is followed by a statement of the advantages claimed for it.

Instead of giving a series of letters of recommendation of this system in full, as is generally the custom, and which are usually too long to be read by busy men, this company have given only short extracts from such letters which take little time to be read, and occupy only a small portion of space. It is thought, though, that these recommendations would have been more satisfactory if the names of the writers had been given.

After these extracts, directions for the use of the Sewall coupler and the measurements required for applying it. The pamphlet concludes with a list of parts of the coupler, some remarks about car heating hose and the guarantee thereof, and of the number of patents owned by the company.

Part III of their catalogue is on the improved (McElroy) commingler system of heating. This system is explained in the first paragraph of the pamphlet, in which it is said:

In continuous train heating from the locomotive, the most satisfactory forms of apparatus have been those in which steam from the locomotive is employed to heat a water circulation within each car of the train. The even and agreeable temperature found when water is employed as a heating medium is due to the great capacity of water for absorbing and storing heat when too much heat is admitted to the car, and for yielding up the stored heat when there is not sufficient steam to maintain an even temperature.

The "commingler" itself consists of a pear shaped vessel, on the inside of which is a perforated steam pipe connected with the supply pipe from the locomotive. The perforated pipe is surrounded with pebbles, through which the escaping steam must pass, and which makes the discharge noiseless. To the upper part of the commingler the hot-water pipes are connected. The flow of steam is broken into hundreds of small jets within the body of pebbles in such a manner as to silently force the water through the commingler and into the hot-water pipes after imparting to the water the entire heat of the steam.

The first five pages are devoted to an explanation of the system, which is illustrated by a number of excellent engravings. The mistake has been made—which is very common in trade catalogues—of assuming that the readers know a great deal more of the subject discussed than they generally do. The description of the system is not sufficiently explicit and detailed. It would add to the interest and value of the publication if there was a clear description of the general principles of the system;

then a detailed account and explanation of how it works, showing clearly the direction and course of the circulation of the steam and water, and then full, detailed illustrations and descriptions of the different parts. Men who write books of this kind, and who know all or nearly all that needs to be known about the subject of which they are writing, should try to assume the attitude of mind in regard to the apparatus described that a person who knows nothing at all about it must occupy. It should also be kept in mind that a considerable proportion of the people who will, or should, read a pamphlet of this kind will be more or less stupid—usually more—and will not be quick in apprehending a description of any mechanism. Whatever is written, therefore, should be made as clear and as explicit as possible. The same remarks will apply to the illustrations. *Lucidity* is the characteristic to be aimed at in all such and other publications.

The descriptions in the pamphlet before us are, however, full enough to enable any one familiar with the general subject of steam heating of cars to understand the system explained; but the usefulness of it would be widened if the needs of those who are totally ignorant of what is explained and also those of the wayfarer and fool were kept in mind.

Following the description of the commingler system is a statement of its points of advantage and directions for operating it. Then follows a detailed description, illustrations, and a list of the different parts.

The second portion of the book has a description and a very good engraving illustrating the commingler storage system. This is treated in a similar way to the return system.

In the third part the commingler return system for elevated and English railroad cars is described.

Both of the pamphlets are well illustrated and printed, and will be of interest and use to all who are concerned in the important subject of which they treat. Our criticisms apply not especially to them, but to trade catalogues generally.

A Story of To-day: Sioux City, its Commerce and Manufactures. Sioux City, Ia.; Compiled and Published by the Jobbers' & Manufacturers' Association. December, 1892.

AMERICAN AND ENGLISH LOCOMOTIVES.

With this number of the Journal we give very complete illustrations of the boilers of the two engines illustrated by general views last month. The striking feature of the difference in the size of the two boilers appears if we compare figs. 3 and 13, although this difference has been slightly exaggerated by the fact that in photographing the blue print from which fig. 3 was taken allowance was not made for the shrinkage of the print, whereas fig. 13 was made direct from a drawing. The extended smoke-box of the American boiler also adds to this exaggeration. The real difference is shown by the amount of grate and heating surface in the two boilers which, as given last week, is as follows:

	Grate Surface.	Heating Surface.
American engine.....	27.3 sq. ft.	1821.5 sq. ft.
English "	18. "	1367.76 "

The American boiler, therefore, has 51.6 per cent. more grate and 33.1 more heating surface than its English cotemporary. If we take the sum of the cubical contents (in inches) of the spaces swept through by the pistons during one revolution of the wheels and divide by the circumference of the wheels in inches, we will find that the cylinder capacity of the English engine is 110.4 cub. in. for every inch in the circumference of its wheels, whereas the American engine has only 102.5 cub. in. It will thus be seen that the American engine has more boiler and less cylinder capacity than Mr. Adams's engine. The effects of these differences in proportion will be discussed when we come to consider the performance of the two engines. The following are the

SPECIFICATIONS FOR BOILER OF AMERICAN LOCOMOTIVE.

Boiler.—To be of the best workmanship and material; to be capable of carrying with safety a working pressure of 180 lbs. per square inch, and of sufficient capacity to supply steam economically. All horizontal seams with butt joints quadruple riveted, with welt strips inside and outside. A double-riveted seam uniting waist with fire-box. All plates planed at edges and caulked with round-pointed tool. Boiler to have extended front end. Waist, dome and outside of fire box of steel $\frac{1}{2}$ and $\frac{5}{16}$ in. thick; throat, $\frac{1}{2}$ in. thick. Diameter of waist at front end, 58 in., made wagon top, with one dome 30 in. in diameter placed on wagon top.

Fire-box.—Of best quality of fire-box steel, $96\frac{5}{16}$ in. long, $40\frac{1}{4}$ in. wide; Front, $70\frac{1}{2}$ in.; Back, $58\frac{1}{2}$ in. deep. Crown-sheet, $\frac{1}{2}$, tube-sheet $\frac{1}{2}$, side and back sheets $\frac{5}{16}$ in. thick. Water space, 4 in. front, 3 in. sides, 3 in. back. All sheets thoroughly annealed after flanging. Fire-box ring double riveted. Stay-bolts $\frac{7}{8}$ and 1 in. in diameter, screwed and riveted to sheets, and placed not over 4 in. from center to center.

Crown-sheet supported by crown-bars made of two pieces of wrought iron 5 in wide, $\frac{7}{8}$ in. thick, placed not over $4\frac{1}{2}$ in. apart, reaching across crown and resting on edge of side-sheets. Crown-bars riveted to crown-sheets with $\frac{7}{8}$-in. rivets placed not over 4 in. from center to center, each bar having four stay-braces to top of boiler or dome.

Tubes.—Of charcoal iron 11 W. G., 268 in number, 2 in. in diameter, 12 ft. in length. Set with copper ferrules at both ends, swedged at back end and beaded both ends. Cleaning-holes at corners of fire-box, and blow-off cock in throat.

Grate.—Rocking.

SPECIFICATIONS FOR BOILER OF ENGLISH LOCOMOTIVE.

Boiler Plates.—The barrel, smoke-box tube-plate, fire box casing and throat and back plates of fire-box, also all dome-plates and butt-strips to be made of the best mild steel of the exact dimensions, both as regards form and thickness, as given on the drawings. To be supplied by makers approved by the Railway Company's Locomotive Superintendent.

Quality.—The quality of the material to be that generally known as mild steel plate, and to be free from silicon, sulphur or phosphorus. The ultimate tensile strain that the plates will stand to be not less than 25 nor more than 30 tons per square inch, and to have an extension of not less than 23 per cent. in 10 in.

Manufacture.—All plates to be made in the most approved manner from ingots hammered on all sides, and, when re-heated, to be rolled truly to a uniform thickness. Both sides to be perfectly clean and free from pitting, roll-marks, scale, dirt, overlapping, or other defects. Each plate to be taken from the rolls at a full red heat, and allowed to cool gradually on a flat surface. Each plate is to be sheared to the dimensions given, and in no case to be sent out before being leveled sufficiently true for machining. All plates that are wavy or buckled, or in any way defective, will be rejected, and must be replaced by the makers free of cost. The maker's name and date of manufacture must be legibly stamped on every plate, and not nearer the edges than 9 in.

A sample or test plate at least 2 ft. square must be sent in by the maker as a sample of what will be supplied in the plates to be made under this contract, together with a complete analysis of the same. This test plate is to be $\frac{1}{2}$ in. in thickness, and from it pieces will be taken for proving in the following manner:

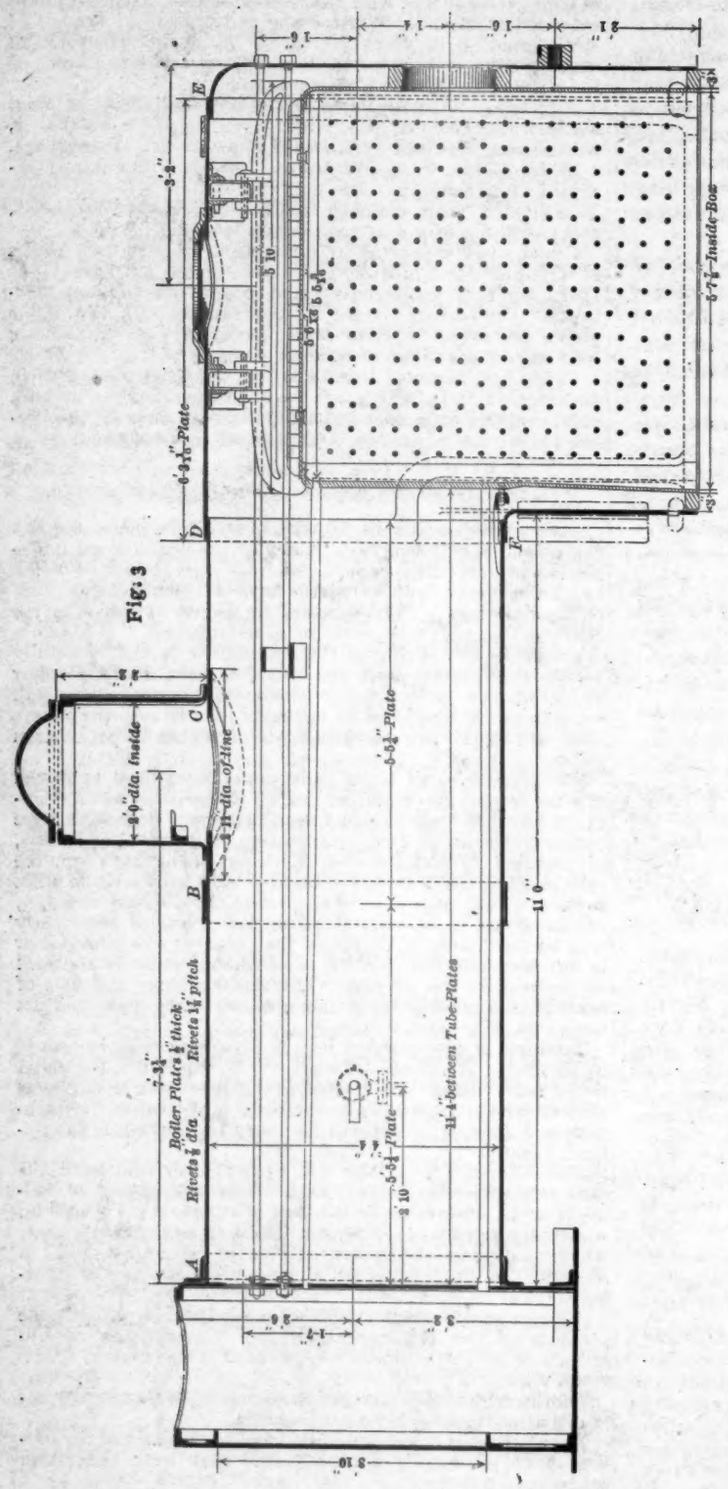
Test.—A piece 6 in. long will be bent over cold until the ends meet each other closely, and no fracture or sign of failure is to be observable in the heel of the bend. Pieces 3 in. wide will also be taken and a $\frac{1}{2}$-in. hole punched through same, which shall stand being drifted cold by taper drifts until it reaches $1\frac{1}{2}$ in. in diameter without the edges fraying or showing signs of fracture.

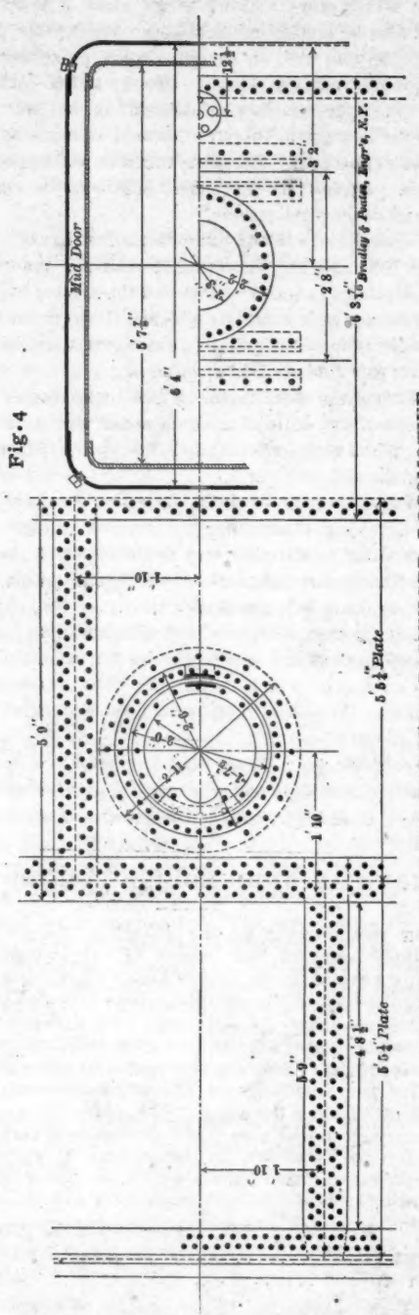
Samples or shearings from the plates must be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, on the premises of the maker, whenever desired.

The barrel and fire-box casing plates to be thoroughly annealed after the rivet holes are punched.

The smoke-box tube-plate, throat and back plates of the fire-box to be thoroughly annealed after they have been both flanged and punched.

Boiler Barrel.—The boiler barrel is to be cylindrical and butt-jointed, and is to be made in all respects as shown on drawings; it is to be 11 ft. long between the smoke-box tube-plate and the throat-plate of the fire-box shell, 4 ft. 4 in. outside diameter, and composed of $\frac{1}{2}$-in. plates. The longitudinal joints are to have inner and outer covering strips double riveted, the rivets being placed zigzag. The transverse joint to





BOILER OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

DESIGNED BY MR. W. ADAMS, LOCOMOTIVE SUPERINTENDENT OF THE LONDON & SOUTHWESTERN RAILWAY. BUILT AT THE NINE-ELMS SHOPS OF THAT COMPANY.

(For description, see page 59.)

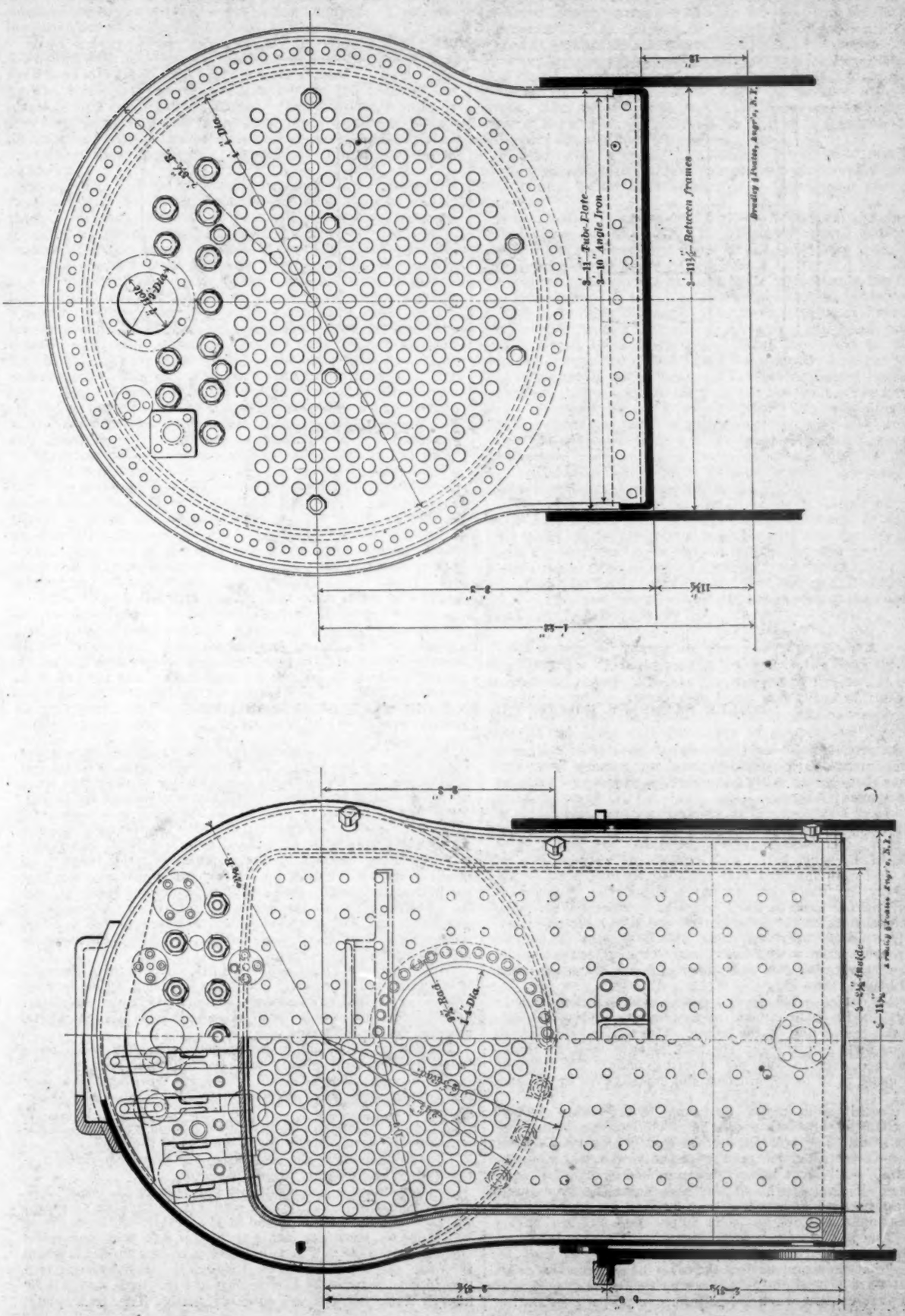
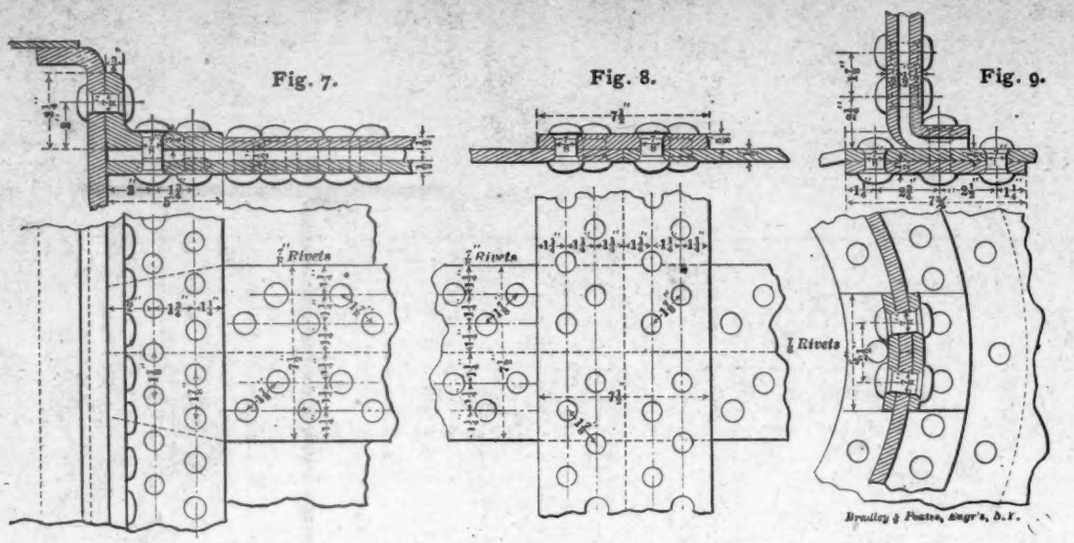


Fig. 5. END VIEWS OF BOILER FOR ENGLISH EXPRESS LOCOMOTIVE.

(For description, see page 60.)



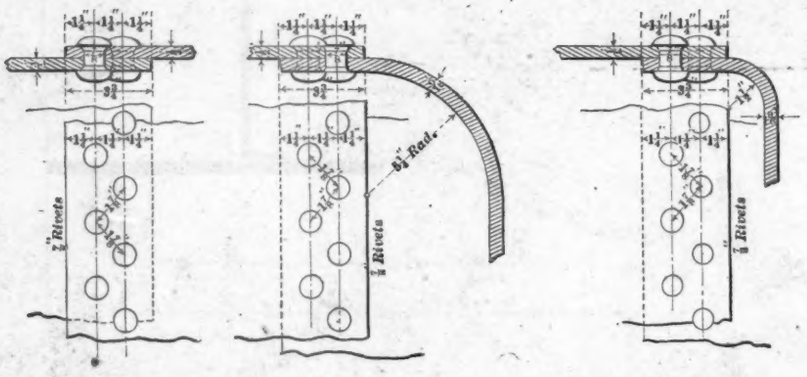


Fig. 10. Fig. 11. Fig. 12.

BOILER SEAMS OF BOILER FOR ENGLISH EXPRESS LOCOMOTIVE.

have an exterior steel weldless ring double riveted. Ring to be turned inside to gauge and to the exact diameter necessary, and then shrunk on. All studs and fittings are to be fixed before the boiler is tested.

Smoke-box Tube plate.—The smoke-box tube-plate is to be $\frac{7}{16}$ in. thick, the tops and sides of the plate being turned forward $2\frac{3}{4}$ in., forming a flange for the smoke-box, and is to be secured to the boiler barrel by a continuous weldless ring of angle steel well annealed, and supplied by makers to be approved by the Railway Company's Locomotive Superintendent. The ring must be faced, bored, and turned on the edges, and then shrunk on the boiler barrel, and is to be double riveted to the same, the rivets being placed zigzag. The tube-plate is to be faced where it is joined to the boiler steel angle. Eight wash-out plugs are to be inserted in the plate, as shown on drawing.

Fire-box Casing.—The fire-box casing is to be 6 ft. 4 in. long and 3 ft. $10\frac{1}{4}$ in. wide outside at the bottom, and to be 5 ft. below the center line of the boiler. The top and sides are to be in one plate $\frac{1}{4}$ in. thick. The back plate to be $\frac{9}{16}$ in. thick, and flanged over to join the covering plate. The front or throat plate is to be $\frac{9}{16}$ in. thick and flanged over to join the barrel.

All riveted joints in fire-box casing to be double riveted. The expansion brackets are to be riveted to the sides of the fire-box shell. The holes in fire-box casing plates for copper stays are to be drilled and then tapped to form a good thread.

Riveting.—All rivet holes to be punched or drilled $\frac{1}{4}$ in. in diameter, all rivets to be of the best Yorkshire iron with a breaking strength of not less than 22 tons per square inch, and an extension of not less than 30 per cent. in 2 in. Rivets to be $\frac{13}{16}$ in. in diameter before being closed, and to be closed wherever possible by a hydraulic pressure of at least 30 tons, so that they properly fill the rivet holes. The holes in the plates are to be slightly countersunk under the rivet heads, and so punched that when the plates are in proper position for riveting the smaller dimensions of the holes shall be together at the center of the joint. All holes in the various plates and angle-irons must be perfectly fair with one another, and must not be drifted in any case; should any of the holes not be perfectly fair they must be rimered out until they become so, and every hole must be completely filled by the rivet. The holes in the angle-irons must be marked from the plates and drilled (not punched), the pitch of rivets and lap of joints being in all cases as shown on drawing. Great care must be taken that the plates are brought well together before any rivets are put in. The edges of all the plates are to be planed before being put together. Any caulking which may be required must be done with a broad-faced tool, care being taken that the plates are not injured by so doing.

Copper Fire-box Plates.—The copper plates to be of the very best quality manufactured, and to be supplied by makers approved by the Railway Company's Locomotive Superintendent, of the exact dimensions, both as regards form and thickness, as given on the drawings.

The copper plates are to be properly annealed, and a piece taken from each plate must stand the following tests, viz.:

The ultimate tensile strain to be not less than 13.5 tons per square inch, with an elongation of not less than 40 per cent. in 2 in.

A piece 6 in. long is also to be bent double when cold, without showing signs of fracture at the heel of the bend.

Tests to be made in the presence of the Locomotive Superintendent of the Company or his Inspector.

Inside Fire-box.—The inside fire-box is to be of copper, 5 ft. $5\frac{3}{16}$ in. long inside at the top, and 5 ft. $7\frac{1}{4}$ in. long inside at the bottom; the height inside at the middle of the box is to be 5 ft. $9\frac{1}{4}$ in., the width inside at the top, 3 ft. 6 in., and at the bottom, 3 ft. $2\frac{1}{4}$ in. The tube-plate is to be 1 in. thick where the tubes and barrel-stays pass through it; the remaining portion is to be reduced by hammering to $\frac{7}{8}$ in. thick, and is to be flanged back to join the covering plate. The back plate,

which must be ½ in. thick, is to be flanged forward. The sides and top are to be in one plate, and ½ in. thick; the joints are to have 2½-in. lap when finished and to be single riveted with ¾-in. iron rivets, same quality as used for boiler. All the joints in the copper fire-box are to be hand riveted. Two fusible plugs are to be fixed in the crown of the fire-box.

Fire-hole Door.—The ring for the fire-door is to be of the best Yorkshire iron, and is to be circular and of the dimensions shown on drawing. The ring is to be riveted to the fire-box by ¾-in. rivets and is to project ½ in. beyond the edges of the plates, which must be well caulked. The fire-door is to be of cast iron, formed in two halves, and made to slide as shown on drawing. A wrought-iron deflecting plate is to be fixed in the fire-door hole as shown. Also a brick arch in the fire-box as shown.

Stays.—The outside and inside fire-boxes are to be stayed together on all sides with copper stays 1 in in diameter and 12 threads per inch, made from best soft rolled bars, having a breaking strength of not less than 14 tons per square inch, with an extension of not less than 40 per cent. in 2 in. properly annealed, screwed steam-tight into both copper and steel plates and afterward riveted over. Great care must be taken in cutting off the ends of the stays so as not to injure the threads. The pitch of the copper stays to be about 3½ in. center to center, as shown. Great care must be taken that the holes in the outside and inside boxes are exactly opposite one another. The barrel stays are to be riveted to the boiler with ¾-in. rivets and secured to the tube plate as shown in the drawing. The inner copper fire-box is to have eight roof stay-bars of cast steel of approved make of the section shown, and secured to it by bolts which are tapped into the stays only as shown on the drawing. The stays are to bear on the top, back and front plates, and are to be slung where shown to the outer shell. The back plate of the fire box casing and the smoke-box tube-plate are to be stayed together with 11 wrought-iron longitudinal stays 1½ in. in diameter where they pass through the back plate, and 1¼ in. in diameter for the remainder of their length; these stays are to have the head bedding on a copper washer and screwed into the fire-box plate; at the other end they are to be secured by a nut bedding on a copper washer on each side of the plate.

Tubes.—The boiler is to contain 240 brass tubes, of a brand and manufacture to be approved by the Railway Company's Locomotive Superintendent. Each tube is to be 1¾ in. outside diameter expanded at smoke-box end to 1¾ in. outside diameter for a length of 3 in. and contracted to 1⅝ in. outside diameter at fire-box end. Each tube is to be No. 11 standard W. G. thick at the fire-box end for a length of 1 ft., and then to be drawn tapered to No. 13 standard W. G. thick at the smoke end, the taper being on the inside only, the outside remaining parallel. The proportion for the metal in the tubes to be 70 per cent. best selected copper and 30 per cent. best Silesian spelter. The tubes are to be inspected by the Railway Company's Locomotive Superintendent or his Inspector, and supplied clean, and are not to be covered with paint or any similar coating. The maker's name to be clearly stamped on the outside of each tube. The tubes are to be expanded by a Dudgeon's tube expander, and ferruled at the fire-box end only. At the smoke-box end the tubes are to stand through the plate ¼ in.

Dome.—The steam dome is to be made as shown on drawing, and to be provided with steel cover. The dome is to be 2 ft. 0 in. inside diameter and 2 ft. 2 in. high inside, and ½ in. thick. The dome is to be made in one plate and butt jointed as shown. A strengthening plate ½ in. thick is to be riveted to the inside of the boiler under the dome as shown on drawing. The hole for the dome is to be 19½ in. in diameter. A soft-steel manhole seating is to be single riveted to the center of the fire-box top, and fitted with a cast-iron cover-plate formed in one with the safety-valve columns. The cover-plate and manhole seating are to be accurately faced, so that a perfect steam-tight joint can be made.

Regulator.—In the inside of the dome is to be placed a cast-iron regulator in two parts with flanged joint, to have two valves, main valve of brass and the easing valve of cast iron, to be worked from the back of the fire box. The steam-pipe leading from the regulator to the smoke box is to be of hard-drawn copper, No. 6 standard W. G., 5½ in. inside diameter, and is to have a brass flange brazed on where it fits into the tube-plate; the other end of the pipe to have a brass collar brazed on, and is to be secured to the stand regulator pipe as shown.

Water Space.—The water space between the fire-box and shell is to be 3 in. wide at the foundation ring, and is to be enlarged upward to the dimensions shown on drawing.

Foundation Ring.—The foundation ring is to be of the best Yorkshire iron, 3 in. wide × 2½ in. deep, and riveted to the inside and outside fire-boxes with ¾-in. rivets, snap-headed, 2-in. pitch, to the section as shown on drawing.

Ash-pan.—The ash-pan is to be placed below the fire-box casing, with movable doors and perforated dampers at the back and front, so arranged as to be worked from the back of the fire-box. The handles for working the doors are to be placed at a convenient height on the foot-plate as shown. The sides are to be of ½-in. plates and the bottom of ½-in. plate, of Best Best Staffordshire iron; angle-irons 2 in. × 2 in. × $\frac{7}{16}$ in. thick are to be riveted to the sides and bottom with ¾-in. rivets. The ash-pan is to be of the form, and fixed in the manner shown, by angle-irons 4 in. × 3 in. × ½ in., and cottered pins screwed into foundation rings.

Fire-bars and Carriers.—The fire-bars are to be of cast iron of the form and dimensions shown, and the carriers of wrought iron secured to the foundation ring in the manner shown on drawing.

Smoke-box.—The smoke-box is to be of the form and dimensions shown on drawing. The sides and crowns are to be $\frac{7}{16}$ in. thick, riveted to the flange of the smoke-box tube-plate. The front plate is to be in one, and ⅝ in. thick. An angle-iron, 2½ in. × 2½ in. × ½ in. thick is to be riveted to the front and side-plates. A hole for the door is to be cut in the front-plate 3 ft. 10 in. in diameter. The door is to be of Best-Best Staffordshire iron, ⅝ in. thick, protected on the inside with a shield, placed 1¾ in. from door. Great care must be taken that the door, when closed, is made a perfectly air-tight joint. The cross-bar is to be made to lift out of forged brackets, which are to be riveted to the inside of the front of the smoke-box. Two handles and a gripping screw are to be provided. All the plates are to be clean and smooth, and well ground over. All rivets are to be ⅝ in. in diameter, pitched as shown on drawing, and are to be countersunk and filed off flush. The outside handles are to be finished bright. All lamp-iron brackets are to be fixed as shown.

Chimney.—The barrel of the chimney is to be of good smooth Best Best Staffordshire iron, ¼ in. thick, to have a butt joint, and is to be riveted together with countersunk rivets down the back, having a hoop of half round iron at the top; the bottom is to be of best Yorkshire iron or mild steel plates, ⅜ in. thick, perfectly free from hammer marks, and accurately fitted to the smoke-box. The height of the top of the chimney from rails is to be 13 ft. 2¾ in.

Besides the difference in size of the two boilers, a striking feature is the fact that the fire-box of the English boiler is made of copper, whereas the American fire-box is steel. The tubes of the former are brass and those of the latter iron. It is not easy to obtain reliable data concerning the relative economy and durability of copper and steel fire-boxes and of brass and iron tubes. We hope, however, before these articles are completed, to give some figures to show the average endurance of steel fire-boxes and iron tubes, and will try to obtain some similar data concerning copper fire-boxes and brass tubes.

Regarding the construction of the two boilers, the engravings show more than can be told by a verbal description. The longitudinal seams in both boilers have butt joints* with double welt strips inside and outside, as shown in figs. 7 and 21. From the latter figure it will be seen that the welt strip of the American joint is made wide enough to take two extra rows of rivets, which are spaced twice as wide apart as those in the four middle rows.

The barrel of the English boiler, it will be seen, has butt joints at *B*, fig. 3, with a single exterior steel weldless ring outside, the seam being double, or, more properly, quadruple riveted, as shown in fig. 8. The ring is turned inside to gauge and to the exact diameter necessary, and then shrunk on. This is a refinement of workmanship never practised in this country. The corresponding American seam at *D*, fig. 13, is shown by fig. 20, and is simply a double-riveted lap seam. With reference to the relative merits of the two forms of joints, something may be said for each side. Where a butt joint is used the plates are considered to be less liable to corrosion or grooving along the caulking edge. In a butt joint with a single outside welt the plates are probably less liable to grooving than they are in a lap seam, but the welt may and sometimes is corroded and cracked, and such a defect is not discoverable by internal inspection,

* There is a little doubt at the time this was written whether the longitudinal joints of engine 903 are butt joints with double welt strips or lap joints with welt strips inside, and there was no means of deciding it before going to press. The form of seam shown by fig. 21, however, represents the present practice of the Schenectady Locomotive Works.

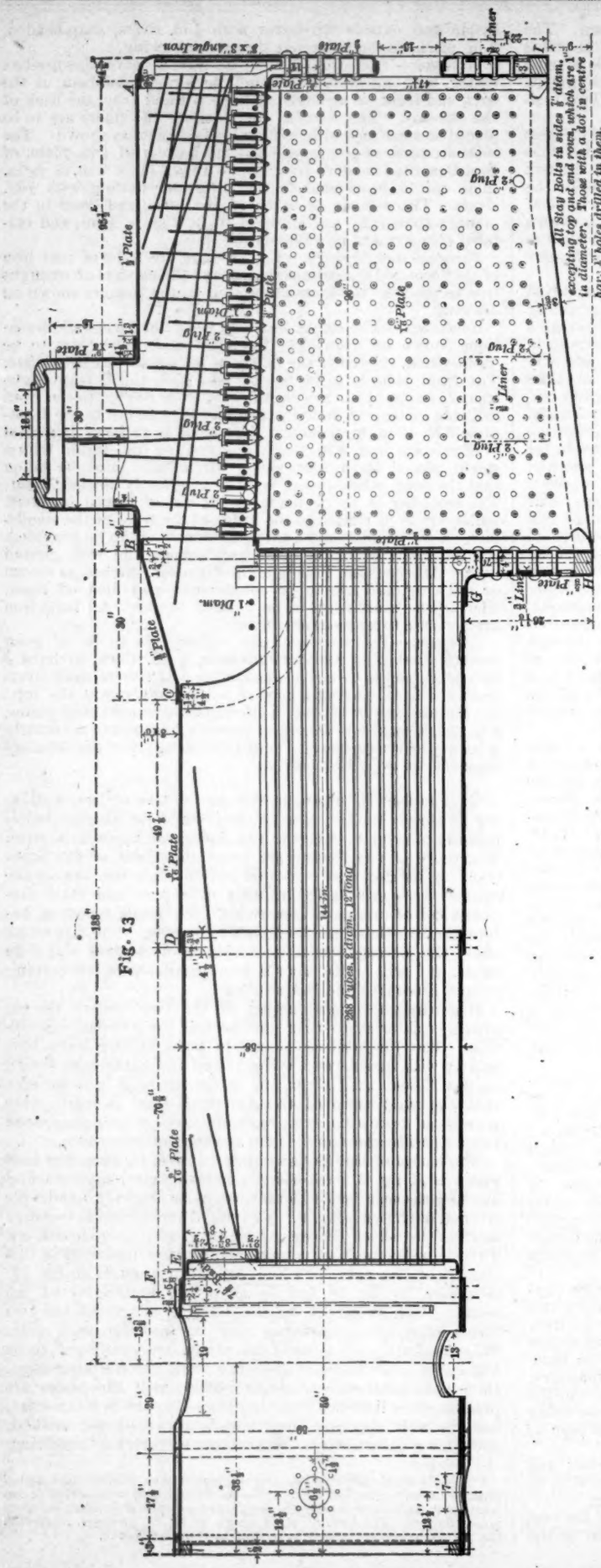

All Stay Bolts in sides 1" diam., excepting top and end rows, which are 1⅛" in diameter. Those with a dot in centre have ½" holes drilled in them.
Liner
2 Plug
1" Plate
⅝" Plate
1" Diam.
268 Tubes, 2" diam., 12' long
143 Sq. Ft.

Fig. 13

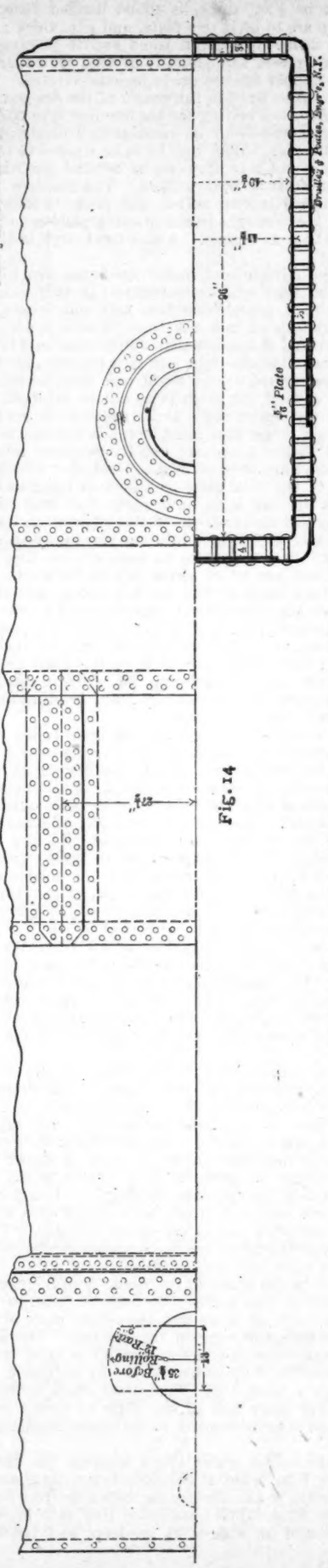


Fig. 14

BOILER OF AMERICAN EXPRESS PASSENGER LOCOMOTIVE.

DESIGNED BY MR. WILLIAM BUCHANAN, SUPERINTENDENT OF MOTIVE POWER & ROLLING STOCK, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.
BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

(For description, see page 58.)

Fig. 16.

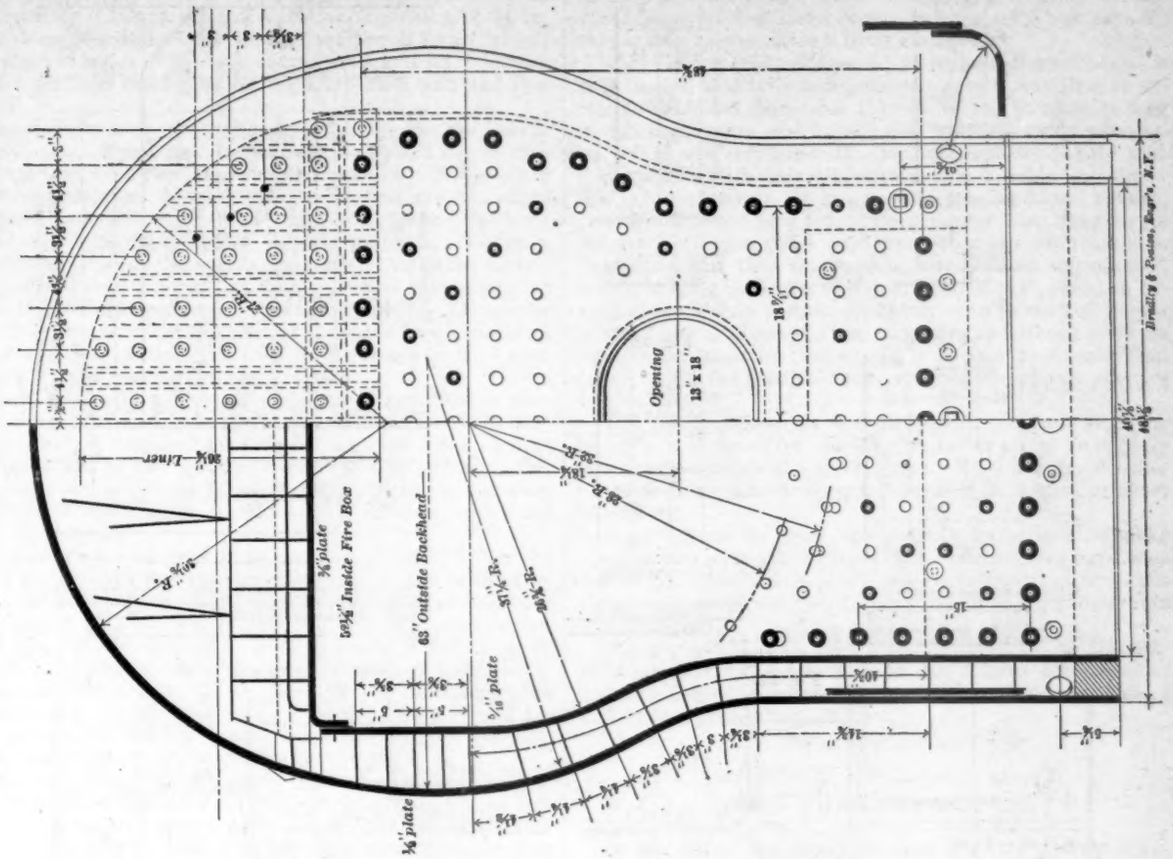
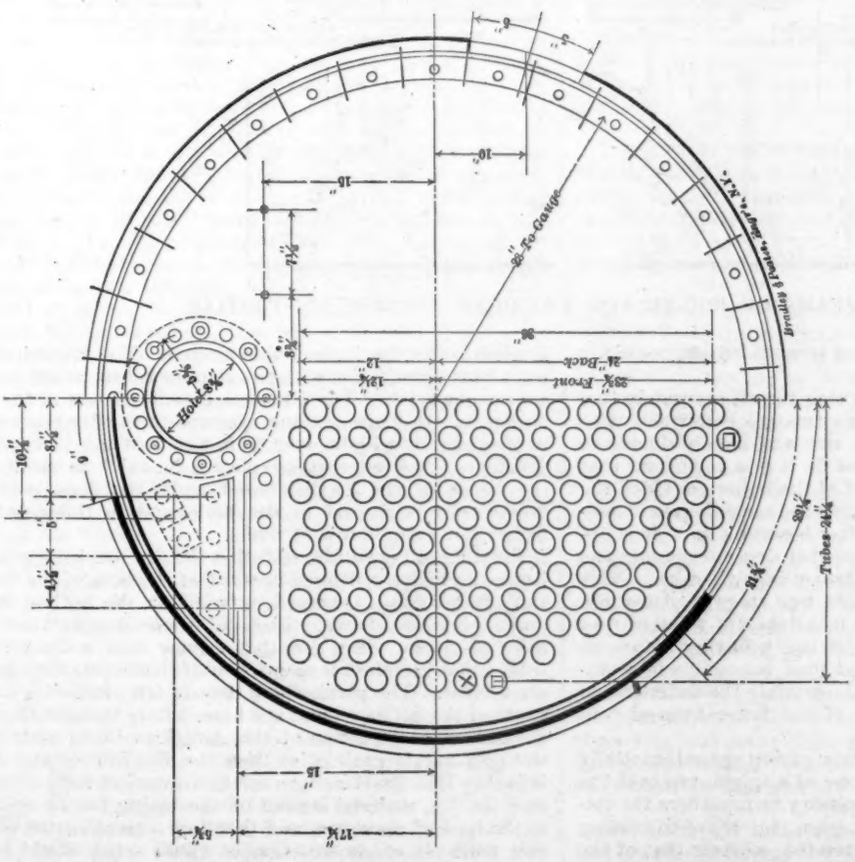
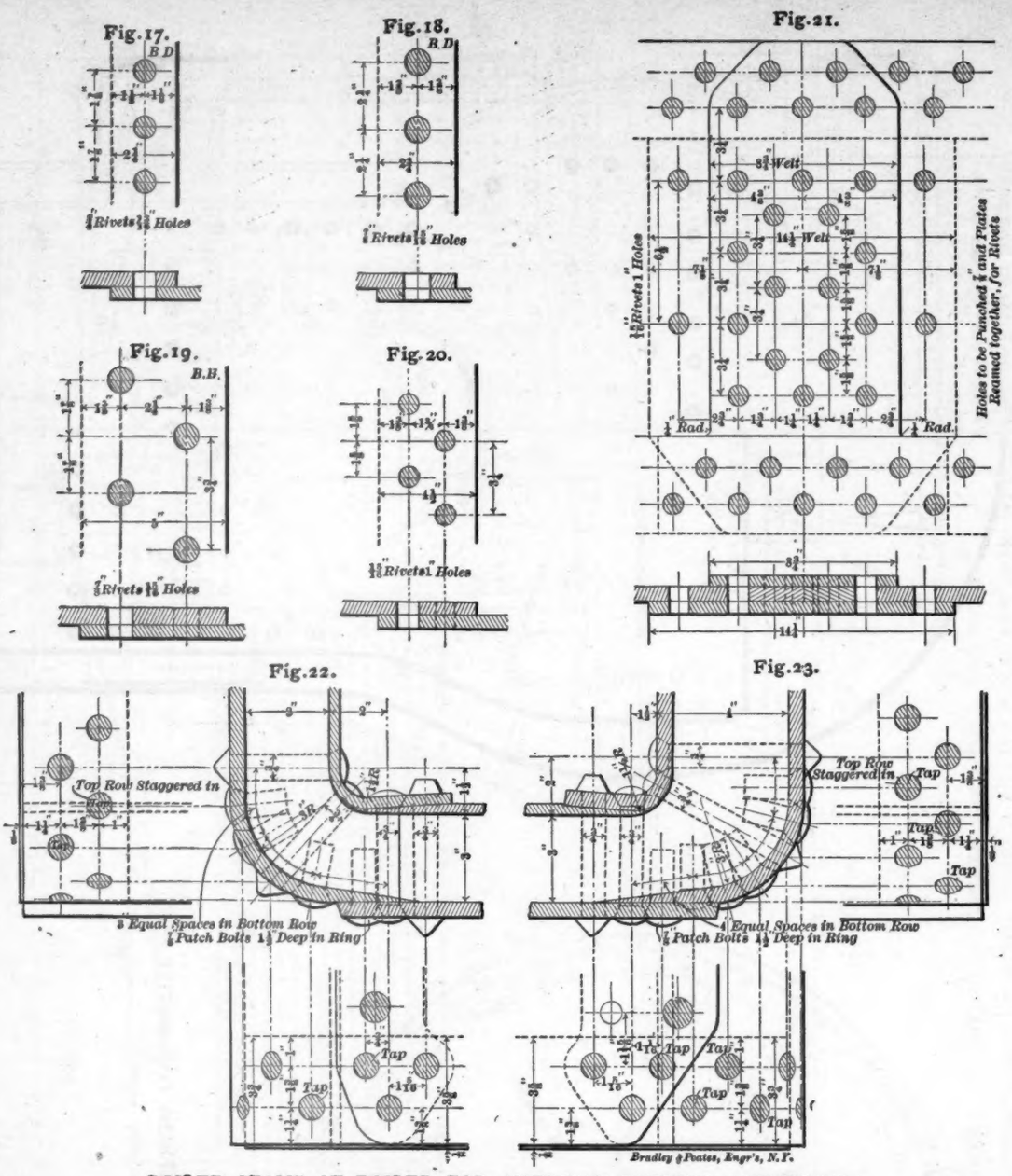


Fig. 15.



END VIEWS OF BOILER FOR AMERICAN EXPRESS LOCOMOTIVE.

(For description, see page 80.)



BOILER SEAMS OF BOILER FOR AMERICAN EXPRESS LOCOMOTIVE.

whereas if the plate in a lap seam is corroded or grooved it can be seen on the inside.

It is true, too, that a weldless ring turned accurately to a gauge and shrunk on a boiler may make a better job than two plates bent to the proper size and merely riveted to each other. But to make a good fit it is as important that the two plates forming the barrel of the boiler on which the ring is shrunk should be made with the same degree of precision as the ring itself if the latter is shrunk on. It is impracticable to turn the plates so that dependence must be placed on the accuracy of the boiler-maker's work. This reliance may be had in fitting the two rings of plates into each other in a lap joint, so that it is doubtful whether very much better work is obtained if the welt ring is turned, shrunk on and quadruple riveted than is possible in a simple lap joint double riveted, and certainly the difference in cost is very materially in favor of the latter form of construction.

The front seams in the fire-box casing are substantially the same in both boilers. The use of a wagon-top over the fire-box makes a gusset plate necessary on top where the casing joins the barrel. The back seam, fig. 18, of the casing of the American boiler is single riveted, whereas that of the English boiler, fig. 11, is double riveted. The English dome has a butt seam, fig. 9, with two rows of rivets, which makes a very good job. The connection of the domes of the two boilers to the barrel in one case and to the fire-box casing in the other it will be seen from figs. 3, 9 and 13 are quite different. A strengthening plate $\frac{1}{2}$ in. thick is riveted to the inside of the English boiler under the dome, and the dome itself is riveted to the boiler and to this ring by a flange and a single row of rivets.

From fig. 13 it will be seen that the fire-box casing of the American boiler is flanged upward at the base of the dome, and another flange is turned outward on the bottom of the dome plate as shown. Each of these flanges take two rows of rivets. It is rare that a dome fails in the vertical seam; and therefore it seems doubtful whether butt seams are needed. The point where they do fail oftenest is in the angle of the flange around the base. It is thought that the method of construction of the American boiler adds more strength to this weak point than the English method does. It is true that the American method does not fully compensate for the material cut out of the casing for the opening at the base of the dome, and therefore a combination of the two methods of construction, it would seem, would be an

improvement over either. The suggestion would be to make a ring of iron or steel of a section of about ¾ × 4½ in. welded or rolled into the form of the tire of a cart wheel, and place it inside of the base of the dome, and let the rivets in the vertical seam pass through the ring and the two plates.

The difference in the method of forming the fire-hole is shown in figs. 3 and 13. In the one case a solid bar or ring is riveted between the inner and outer plates. In the other the two plates are flanged, the one inward and the other outward, and riveted together. The first method has been abandoned here and the other substituted for it. The only difference in the mud or foundation rings is that in the American boiler it is 3⅝ in. deep and double riveted, whereas in the other it is only 2½ in. deep and single riveted. The necessity of double riveting this part of large fire-boxes has been made apparent within the past few years, and it is now generally done here in the best practice.

From fig. 13 it will be seen that two extra rows of stay bolts are placed along the upper part of the sides of the fire-box. This is the usual practice on the New York Central Railroad, but is not generally employed elsewhere. The stay-bolts are of iron ⅝ in. in diameter excepting those on the top and end rows on the sides of the fire-box, which are 1 in. in diameter.

The crown-bars or roof stay-bars of the English boiler are made of cast steel and extend lengthwise on top of the fire-box; those of the American structure are made of two bars of wrought iron welded together at the ends, and extend crosswise of the fire-box. With a fire-box 8 ft. long it would be impracticable to place the crown-bars lengthwise. In one as short as 5 ft. 7½ in. a good job can be made in the method used by Mr. Adams. In both cases the bars are connected to the casing by sling stays, but of quite different forms and methods of construction.

The relative merits of straight-top and wagon-top boilers have been much discussed in this country. In favor of the first it is said that they give more room for steam over the fire-box and for men to work, and for inspection inside of that part of the boiler. In favor of straight-top boilers it is said that they are stronger and cheaper. At the present time the preponderance of opinion seems to be in favor of wagon tops, although it is thought that their apparent advantages are due more to bad designing of the straight-top form, and to the fact that when wagon tops are used they are usually made considerably heavier than straight boilers. If made of equal weights, it is believed that as good or better results may be obtained with straight as with wagon-top boilers, and with somewhat less cost for the former. On straight boilers the dome should obviously be placed near the middle of their length, because at this point there is less variation in the height of the water and less effort, due to the "swash." If a wagon top is used, the dome may be placed over the fire-box, because the additional height compensates somewhat for the difference due to its position. In fact, wagon tops have often been used because it seems desirable to place the domes over the fire-box.

The longitudinal stays of the one boiler, it will be seen, extend horizontally from the back-head to the front tube plate, whereas in the American boiler they are placed diagonally and attached to the fire-box casing or the barrel of the boiler. The former plan was a very common one here twenty or twenty-five years ago, but has since been generally abandoned. The tremor of the rods, it was found, broke them and caused them to leak when they passed through the heads.

Another point of difference in the construction of the boilers is in the method of attaching the smoke-boxes to the barrel, and in the fact that the smoke-box of the English boiler is made of larger diameter than the barrel. This, it is thought, is an advantage, as it gives more room for steam pipes, etc., inside, and they can thus be kept clear of the tubes. The tube plate is "secured to the boiler barrel by a continuous weldless ring of angle steel well annealed. . . . The ring must be faced, bored and turned on the edges and then shrunk on the boiler barrel, and is to be double riveted to the same, the rivets being placed zigzag. The tube plate is to be faced where it is joined to the boiler steel angle." This, it will be seen, makes a very good job, but is considerably more expensive than the method of construction shown in fig. 13. Whether the advantage of having more room in the smoke-box pays for this extra expense seems a little doubtful.

Regarding the advantages of an extended smoke-box, it may be said that it is comparatively easy at any time to excite an animated discussion thereon among locomotive men in this country, in which each side will be warmly advocated. It is now very generally used, and the idea is held that a locomotive with this attachment is less liable to "throw fire" than without. It is generally admitted, we believe, that locomotives here are worked harder than they are in England. Under these conditions they are more liable to throw fire and thus do damage, especially in our climate, which is drier than that of Great Britain. If, then, an extended smoke-box permits a locomotive to be worked harder without doing damage than it would be without such an attachment, then to that extent it is an advantage. That seems to be the verdict deduced from the general practice in this country.

The specifications say and the drawings show that the holes in the plates for the English boiler are to be slightly countersunk under the rivet heads. This is a decided improvement on American practice, as it is seldom or never done here.

It is difficult to draw any general deductions or make comparisons until all the parts of the two engines have been described, therefore these will be reserved until after all the different parts of the two locomotives have been illustrated and discussed.

We may add that we are further indebted to the Schenectady Locomotive Works and to Mr. Adams for copies of specifications of the engines, from which we have quoted, and expect to use in future articles.

(TO BE CONTINUED.)

SOME CURRENT NOTES.

In his annual message, Governor Flower, of New York, follows the line of his predecessor in urging road improvement, and in advocating State assistance to local communities in building roads.

The Governor of Pennsylvania also refers to the road question at considerable length. He advocates improvements in the road laws and a better system of taxation for road improvements and maintenance.

The difficulty of soldering aluminum, which is believed to result from the formation of a thin film of oxide on the metal, has been overcome by the use of a flux containing a small amount of phosphorus, which serves to deoxidize the surface and leave it clean. This solution was discovered by Mr. Joseph Richards, of Philadelphia.

In his recent message to the Legislature, Governor Flower, of New York, urges very strongly the necessity of preserving the Adirondack forests for the general benefit of the State, and refers to the great injury which may be done by any further indiscriminate cutting or clearing of the woodland in that region. His warning is a timely one, and should be heeded.

On the Austrian railroads considerable attention has been given to planting trees along the slopes of the railroad cuts and banks, and in other places where there is room on the right-of-way. In some places these are intended to act as wind-breaks and defenses against snow; in others they are simply to utilize the waste land. A recent statement shows that these plantations, as reported up to date on the various lines, include about 370,000 fruit trees of various kinds—plum, pear, apple, peach, apricot and others—and about 3,600,000 forest trees. Some of the latter, such as willows, are planted chiefly on account of the use of their roots in preserving and consolidating slopes; others—oak, fir, pine, larch, etc.—will be valuable in due time as timber. These plantations are being extended each year.

On January 1 there were, according to the *American Manufacturer's* tables, 250 furnaces in blast, capable of a

total weekly production of 175,701 tons of pig iron; an increase of a little less than 1 per cent. during December. The capacity of the furnaces in blast, however, is less by 15,741 tons, or 8 per cent., than it was on January 1, 1892, although it is greater than is shown by the report for any month since April. The tendency for several months past has been to a slight but steady increase.

The *American Manufacturer* also estimates the total production of pig iron for 1892 at 9,139,711 tons; an increase of about 10½ per cent. over 1891, but a decrease of 1 per cent. from 1890. The year 1892, however, shows the largest production—with the exception of 1890—of any year in our history.

The big lifting bridge over the Harlem River on the New York Central & Hudson River Railroad, which was described some time ago in our columns, was successfully moved recently to a point some 60 ft. west of its original location. The moving of the great tower—127 ft. high and weighing 180 tons—was actually completed in 21 minutes; but the preparations for the work occupied several days. The removal was made necessary by the fact that a new bridge will have to be built in connection with the raising of the tracks across the Harlem.

According to the statements prepared by the *Railway Age* there were 4,062 miles of new railroad built in 1892—less than in any year since 1885, but still an appreciable addition to the railroad system of the country. The activity in construction was greatest on the Pacific Coast and in the South, although there was a fair amount of work done in Ohio, Indiana and Michigan, and more in New York and Pennsylvania than for several years past. A large proportion of the new mileage was in short lines and branches.

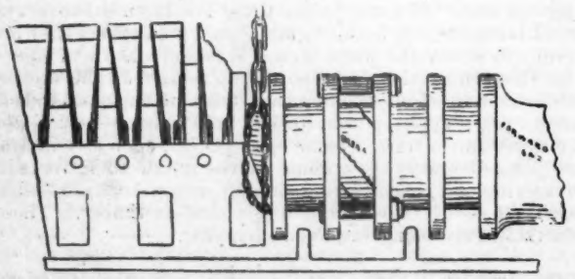
The truck for long passenger cars is considered a necessity by Mr. Dundas, President of the Institution of Engineers & Shipbuilders in Scotland. He does not consider the radial axle a satisfactory device.

The latest use of aluminum is for slate-pencils. Major von Sillich found that the metal would mark on slate, and the pencils are now made by a German company. They need no pointing, will not break and will last a long time.

In a recent lecture in Sheffield, England, Professor Ripper stated that, in spite of the great improvements made, our present engines and boilers utilize only from 4 to 6 per cent. of the total heat generated. Chimney draft alone cost from 20 to 30 per cent. of the fuel burned, and other losses were found everywhere.

The longest balloon trip on record, it is claimed, was made in October last by M. Maurice Mallet. In his balloon, which he has named *Les Inventions Nouvelles*, he ascended from La Villette, near Paris, on October 23, and ended his voyage on the following day at Walhen, in Germany, having been in the air a little over 36 hours.

Most of our readers have probably seen in the daily papers some account of the accident to the Cunard steamer *Umbria* and its repair in mid-ocean; but a brief account will not be out of place here. The main shaft broke in the thrust bearings where the body of the shaft is 25 in. in diameter, with collars 36½ in. in diameter and 3¼ in. thick,



spaced 6½ in apart. These collars are part of the shaft, and some idea of their arrangement is given in the sketch; the break was between two of them, as is also shown. The method of repair adopted was to use two adjoining collars as flanges of a coupling, connecting them by three 5-in. steel bolts. To do this grooves had to be cut in the two collars large enough to take the bolts; the bolts had to be cut to the proper length; the nuts had to be cut down, as they were too large to enter the space; and bands had to be placed around the shaft to hold the bolts in place. The difficulties attending this work at sea, with only the hammer and cold chisel, and in the limited space around the shaft, can be imagined.

The new elevated railroad which runs along the water front of Liverpool a distance of about six miles, is to be operated by electricity. The power station is near the middle of the line, and contains three groups of dynamos, each operated by a 400-H.P. engine. The current is carried by steel bars placed between the rails on porcelain insulators. The cars will be run in trains of two or three, as may be needed, at a speed of 12 miles an hour. Each car will seat 56 persons.

The production of copper in the United States in 1892 is estimated by the *Engineering and Mining Journal* at 325,180,000 lbs., of which 107,200,000 lbs. were from the Lake Superior region and 164,300,000 lbs. from Montana mines. The total is an increase of about 13 per cent. over 1891. Exports diminished slightly, but there was a large increase in the home consumption, so that the stocks on hand at the close of the year were considerably less than at the end of 1891.

The New York Railroad Commission, in its latest report, refers to the lighting of passenger cars as follows: "Success has attended the effort to light passenger cars with gas. Last year the Board set on foot inquiries as to the practicability and safety of the various systems in use, and the answers were assuring in both respects. Indeed, so practical and so successful are the systems, and so widely have they been adopted, that a car in one of the first-class or limited trains lighted by oil would be regarded as a relic of a past age. A sufficient reason why every passenger car, whether a palace or ordinary coach, should not be lighted by gas cannot be given. Economy should not be the prevailing consideration. Aside from the increased security from fire, the annoyance of dripping oil from the lamps is avoided. The lighting of all passenger cars with gas is in line with the progress which has led to heating by steam instead of stoves, and which is leading to automatic couplers instead of the link and pin, coupled by hand, and automatic brakes set from the engine rather than by men on the tops of the cars at the risk of their lives. The prohibition of the use of oil by legislative enactment is desirable."

THE COLUMBIAN EXPOSITION.

From time to time references have been made to the progress of work on the buildings at Chicago, but we now present for the first time a plan showing the general arrangement of the grounds and the position of the buildings; for this cut we are indebted to the courtesy of the *Street Railway Journal*.

This plan designates all the chief buildings by name; but no map that could be given within the limits of our page could show them all in this way. We hope, however, to give hereafter fuller plans in which more detail will be possible.

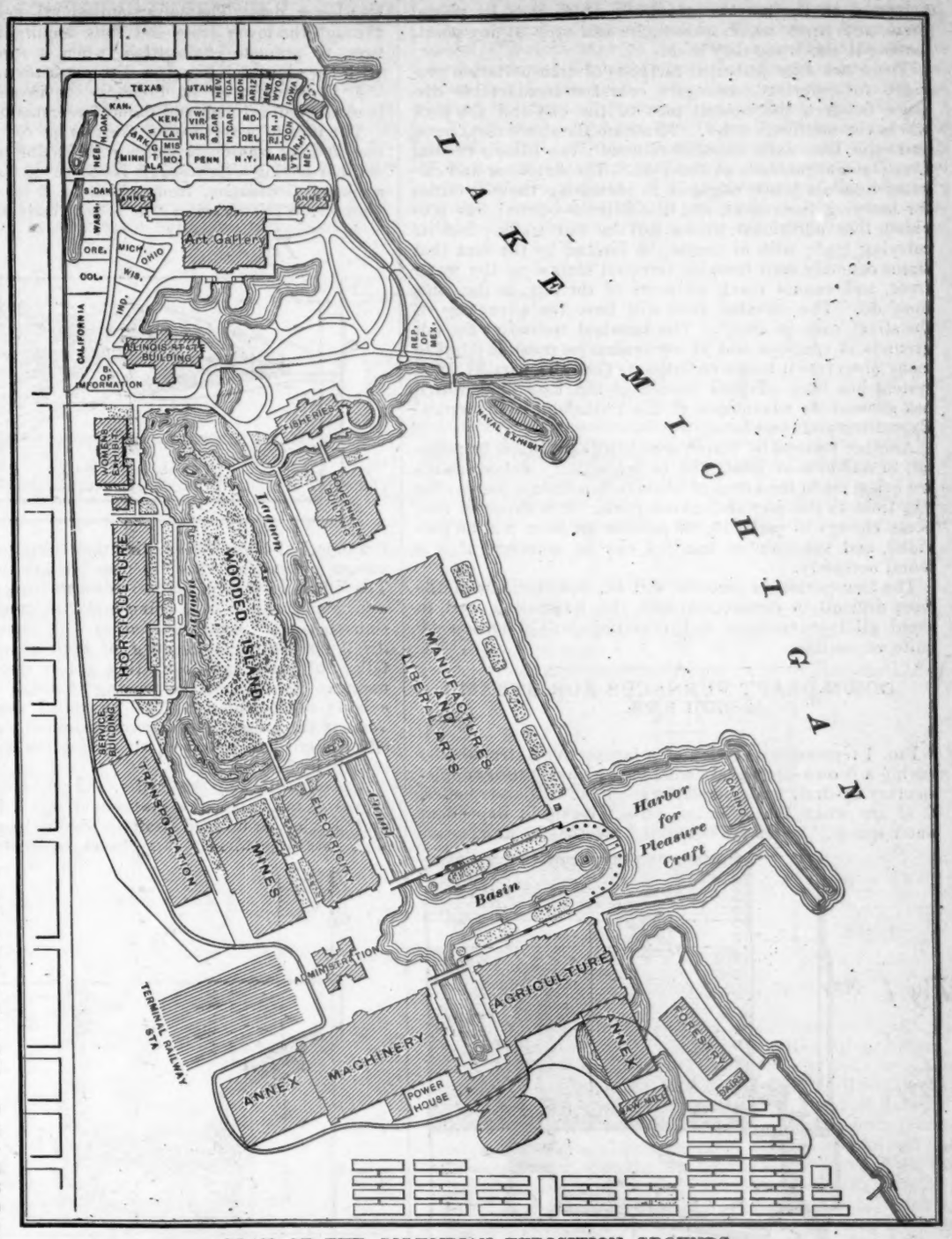
The grading and reclamation of Jackson Park is now substantially completed, and most of the buildings are in a condition where little but the finishing work remains to be done. The progress made with the work is extraordinary, when it is remembered that the designs were not finally completed or adopted until the winter of 1891, and work was not fairly begun until the next spring.

At the time of the opening in October, it was stated that only the decorative work remained to be done, and this statement was substantially correct. In fact, the work of putting in the exhibits was begun soon after, and is now going on.

The great size of the principal buildings is shown by the plan, but will be better understood from some of the figures given. The main buildings have an area of about 5,500,000 sq. ft.; the smaller buildings, 1,155,000 sq. ft.; State buildings, 420,000 sq. ft.; foreign buildings, 300,000 sq. ft.; concession buildings, 1,000,000 sq. ft.; making a total of about 192 acres under roof.

The total space available for actual exhibits is about 3,000,000 sq. ft., of which about 1,300,000 sq. ft. have been allotted to foreign countries, and the remainder to American exhibitors. The applications for space amounted to about two and one-half times that actually available, so that the awards were necessarily much less than was asked for.

It may be added that great precautions have been taken against fire. Mains are laid all over the grounds, and fire-engines are provided, besides connections with the city fire department, and a boat provided with powerful pumps will be kept on the water front.



PLAN OF THE COLUMBIAN EXPOSITION GROUNDS.

The size of the buildings and the distances between them will doubtless dispose visitors to use liberally such means of transportation from one part of the grounds to another as are provided. The first of these is the electrical elevated railroad, which makes a circuit of the grounds, starting from a point near the Agricultural Building at the south end, passing as close as possible to all the principal buildings, and having its loop or terminal circuit near the north end of the Manufactures and Liberal Arts Building. Stations are placed at convenient points, and the road can be used by visitors either to make a complete circuit of the grounds or to pass from one point to another. The total circuit made by this road is about five miles.

Transportation by water will also be available, canals having a total length of 2½ miles having been laid out in the grounds; on these a large fleet of electric launches will ply, carrying passengers from point to point in the grounds. Some of these boats will make a round trip without stops; others will stop at the landings adjoining each building, while a third class will be ready for hire by the hour.

On the Midway Plaisance, which may be called the central avenue of approach to the fair grounds, and which is about a mile in length, the Giffard hydraulic or sliding railroad, which has been described in our columns,* will extend the whole length of the avenue, with stopping-places at convenient points.

Finally, the long pier extending into the lake can be

* See number for October, 1889, page 456.

traversed on the movable sidewalk which will be placed there, and upon which passengers can step at any point, leaving it also when they wish.

There are four principal methods of transportation provided for carrying passengers over the considerable distance between the central part of the city and the park where the buildings stand. These are the street cars, horse and cable lines; the elevated railroad; the Illinois Central Line; and steamboats on the lake. The street car and elevated lines are busily engaged in increasing their facilities for carrying passengers, and the Illinois Central has provided four additional tracks for the fair traffic; but its carrying trade will, of course, be limited by the fact that trains can only start from its terminal station on the water front, and cannot reach all parts of the city, as the cable lines do. The elevated road will have the advantage of the street cars in speed. The terminal station at the fair grounds is spacious and as convenient as possible; but to many observers it seems unfortunate that the parallel track system has been adopted instead of the loop plan, which has showed its advantages at the Philadelphia Centennial Exposition and elsewhere.

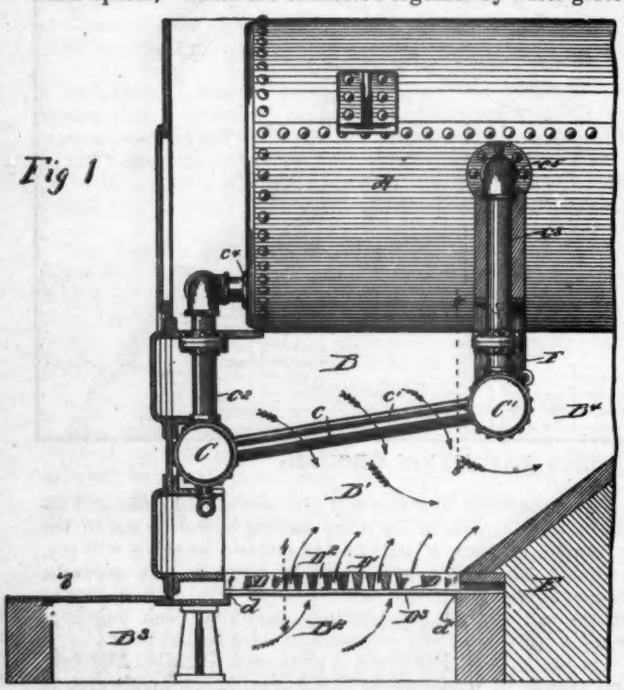
Another method of travel, which will doubtless be popular, in summer at least, will be by water. Arrangements are being made for a fleet of boats to run from a pier on the city front to the pier at Jackson Park. It is expected that boats enough to carry 15,000 persons an hour will be provided, and the number handled can be increased if it is found necessary.

The transportation problem will be, however, one of the most difficult in connection with the Exposition, and to avoid all inconvenience and crowding will doubtless be quite impossible.

DOWN-DRAFT FURNACES FOR STEAM BOILERS.

FIG. 1 represents a section of a furnace for a steam boiler having a down-draft grate combined with a sort of supplementary up-draft grate or platform below. *A* is the boiler, *C C* are what the inventor calls "manifold dependent water spaces," which are connected together by water-grate

Fig 1

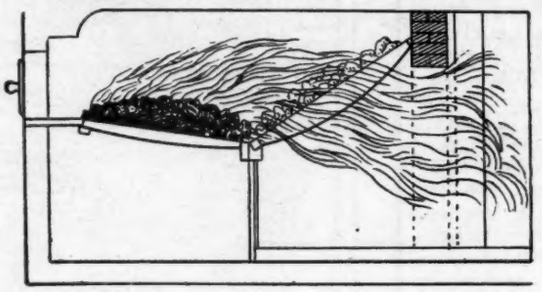


bars *c c'*. The raw coal is fed in on top of these grate-bars. D^1 is a supplementary up-draft grate or platform composed of fire-brick or other refractory material having perforations; its purpose being to receive the incandescent coals that fall from the upper grate and retain them for combustion. The course of the draft is indicated by the arrows, fresh air being admitted above the upper grate and below the lower one. The latter current is heated in passing through the lower grate and thus acquires a high temperature, to promote combustion, when it meets and mingles with the air which has passed through the upper grate.

J. F. Wangler, of St. Louis, is the inventor; his patent is numbered 487,896, and dated December 13, 1892.

The idea of a downward draft is an old and an enticing one, and the combination of a grate having an up-draft with another having a down-draft is shown in C. Wye Williams' book on *Combustion*, from which fig. 2 is copied. Of this plan Mr. Williams said: "It is here introduced as showing

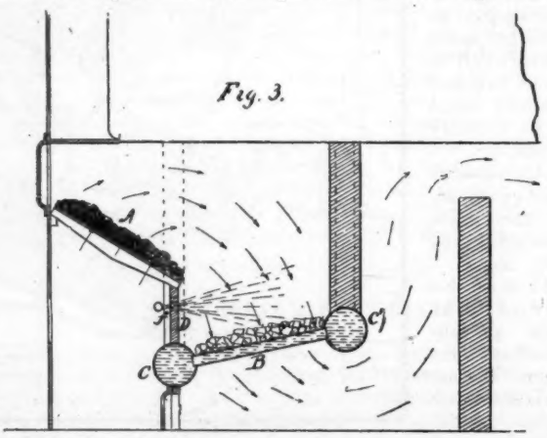
Fig. 2.



the practical error of supposing that the gases could be consumed by causing them to pass *through incandescent fuel*. The effect of this plan is to convert the gas into *carbonic oxide;* and which, from being invisible, created the impression that the '*smoke was burned.*' It is needless here to dwell on the chemical error of such an assertion. The fallacy of imagining that either gas or smoke from a furnace can be consumed by passing '*through, over or among*' a body of incandescent fuel prevailed from the days of Watt to the present. Numerous patented plans to the same effect might here be given, all having the same defect, and equally ineffective."

A plan devised by the writer, and probably by other persons, was to arrange the grates as in fig. 3, in which *A* is a grate having an upward draft to which the raw coal is fed. *C C* are dependent water spaces, connected together by

Fig. 3.



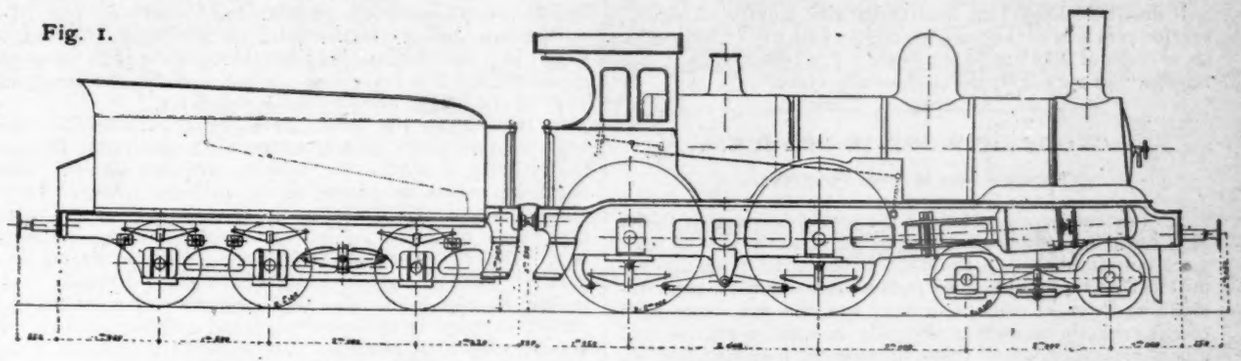
a water-grate *B*, having a downward draft. The grate *A* has an inclination sufficient so that the coal, when it becomes incandescent, can readily be pushed forward on to the grate *B*. In order to get over the defect pointed out by Williams, openings *f* were made in the back plate *D* and a steam-jet *f* was provided which blew steam into these openings and thus created an induced current of air into the space above the grate *B*, which furnished the required amount of oxygen for the combustion of the gases from the raw coal in the upper grate, and of the fuel in the lower grate. The arrows indicate the direction of the currents sufficiently well, so that further explanation is not needed. The plan, so far as the writer was concerned, never got further than the speculative stage, but whether any one else ever put it in practice is not known. It seems to have some merits, but the expectations that may be reasonably entertained of its performance might vanish in a practical test.

A RUSSIAN COMPOUND PASSENGER LOCOMOTIVE.

THE Southwestern Railroad of Russia has had in service for some time a compound locomotive built for fast passenger work, and some interesting notes in relation to this machine were recently contributed by Mr. de Borodine, Engineer-Director of the road, to the French Society of Engineers.

The locomotive is of the four-cylinder type, with the cylinders placed in tandem, the high-pressure and low-pressure pistons acting on the same rod. The steam from the high-pressure cylinder passes through an intermediate receiver in the smoke-box into the low-pressure cylinder on the opposite side, and steam from the boiler can be admitted to the low-pressure cylinders in starting, or at other times when it may be necessary, the apparatus being controlled by the engineer.

Fig. 1.



COMPOUND PASSENGER LOCOMOTIVE, SOUTHWESTERN RAILROAD OF RUSSIA.

The boiler of this engine has a barrel 49¼ in. in diameter, with 208 tubes 1.77 in. in diameter and 12 ft. 6 in. long. The grate area is 20.4 sq. ft. ; the heating surface is : Fire-box, 111 9 ; tubes, 1,205.1 ; total, 1,317.0 sq. ft. The usual working pressure is 165 lbs.

In general design the engine is of the eight-wheel or American type, with four coupled drivers and a four-wheeled truck, as is shown in the accompanying drawings, fig. 1 being an elevation and fig. 2 a part sectional plan, showing arrangement of the cylinders. Fig. 3 shows the arrangement of the high-pressure stuffing-box and the low-pressure cylinder head. The high-pressure cylinders are placed in front and the low-pressure behind.

The driving-wheels are 6.56 ft. in diameter and the truck wheels 3.12 ft. The distance between the driving axles is 8.53 ft., and the truck axles are 6.56 ft. apart. The total wheel-base is 21.65 ft. The total weight of the engine in working order is 94,800 lbs., of which 57,300 lbs. are carried on the drivers. The tender will carry 3,900 galls. of water and 11,000 lbs. of coal, and its total weight when full is 77,100 lbs. The total weight of the engine and tender is thus about 86 tons.

The high-pressure cylinders are 13 in. in diameter and the low-pressure 19.7 in., all being 23.6 in. stroke. The ratio of the cylinders is 1 : 2.30.

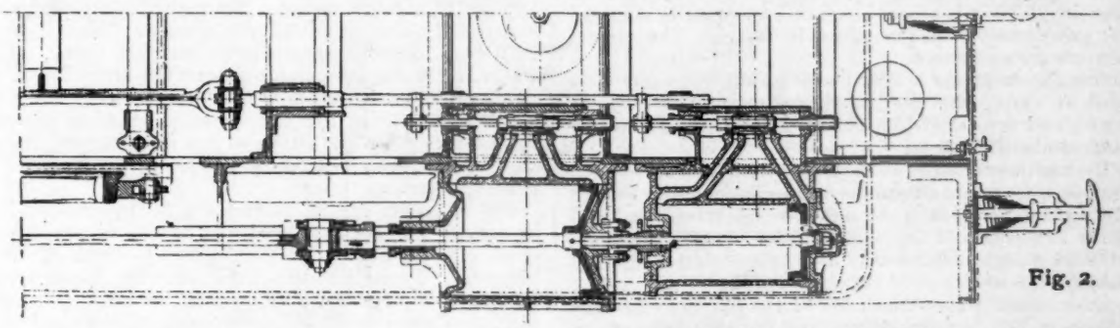


Fig. 2.

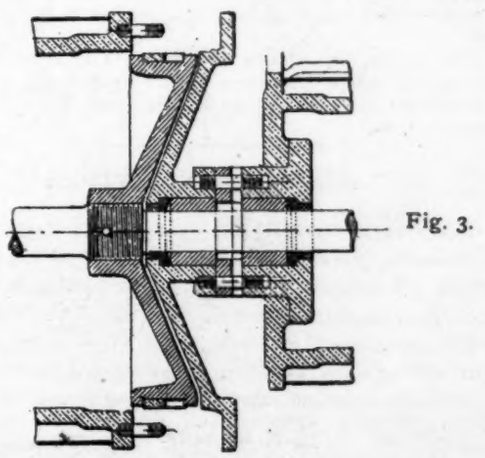


Fig. 3.

The fire-box is of steel and is of the Belpaire type. The engine has Westinghouse brakes, including driver brakes.

Some trials of this engine were recently made by a commission consisting of Mr. de Borodine, Mr. Koribout-Dachkevitch, Engineer-Counsellor of the Department of Railroads, and Assistant Inspector Tichmeneff. From reports presented to this Commission it appeared that the engine had been in regular service on the Kieff-Kasatine Division of the road for nine months, and that it had worked satisfactorily in every respect. The maximum grades on this division are 0.8 per cent., and there are numerous curves. Over this line the engine had frequently hauled a train of 15 six-wheeled carriages, weighing in all 14,700 poods—264 tons—and made regular time. With the ordinary engines in service, two locomotives are usually required when the train consists of more than eight carriages.

Two special trial trips were made by the Commission. On the first the engine, with a train of 15 carriages, made the run from Kieff to Kasatine, 98 miles, making nine stops, in 191 minutes, or at an average speed of 30.75 miles an hour. One of the stops was of 12 minutes' duration. On a grade of 0.8 per cent. a speed of 21 miles an hour was maintained ; and on a descending grade the maximum speed of 46.4 miles an hour was attained. Observations taken during the run showed a variation in boiler pressure from 135 to 165 lbs. The fuel used was coal from the Bogodonhoff mines in the Don District, of which there was burned 3,253 lbs., or 33.2 lbs. per mile run. The report states that 1 lb. of this coal vaporized 8.68 lbs. of water. Diagrams

taken at a speed of 39.8 miles an hour showed that the work done was equivalent to 588 indicated H.P. At stations the engine started easily and quickly, and it kept steam well.

The return trip from Kasatine to Kieff was made with 11 carriages of a total weight of 11,400 poods, or 206 tons. On this trip also nine stops were made, including two of 14 minutes each and one of 6 minutes, and in addition an extra stop of 4 minutes was made near Tchernoroudka, on account of the rupture of an air-brake pipe. The water vaporized was 9.26 lbs. to 1 lb. of coal, and the coal consumption was 25.8 lbs. per mile. The speed was greater than on the first trip, the average being 40.5 miles an hour, and the maximum 56.4 miles an hour.

It may be added that during its nine months of regular service previous to the tests the engine had run 18,905 miles, an average of 2,101 miles a month. The report of the Commission was very favorable to the new type.

GEODETIC WORK IN FRANCE.

(Translated from *Le Revue Scientifique.*)

At a recent meeting of the Academy of Sciences of Paris, M. Bassot presented some facts in relation to the new meridian established in France. It was some years ago admitted that the meridian of Delambre & Mechain, notwithstanding its great value a century ago, did not agree with recent geodetic measurements made in other countries, and a new measurement of this fundamental meridian was ordered in 1869 and begun in 1870.

For 12 years this work was carried on under the direction of General Perrier, with the assistance of MM. Bassot and Defforges; since 1882 it has been under the direction of M. Bassot, with M. Defforges as Chief Assistant. The work is now nearly completed. It may be added that the manner in which it has been done and the results obtained reflect great credit upon the officers in charge. The general statements are as follows:

1. Starting from the base of Paris the measurements were verified at Perpignan, after passing through a distance of about 6°, and agreed within about 1-250,000, with the new measurements of the base.

2. On the lines or sides of the triangulation common with the English, Belgian and Italian triangulations, the French results are almost identical with the foreign results deduced from the new stamp of the *toise* of Bessel; but on the Spanish side there is a difference of 1-65,000, which is not yet explained.

3. In calculating anew the total of the parallel lines and meridians of the French system, the fact has been recognized that the new meridian restores order and harmony among most of the triangulations. It has not, however, done away with the discrepancies noted by the geodetic engineers in the southwest, in the lines adjoining the Bordeaux and Gourbera bases. For this reason the Geographic Service has submitted to the Ministry of War a plan for the immediate renewal of the mean parallel, as a complement to the new meridian.

4. The length of the meridian line between the extreme astronomic stations, the length of which is about 8° 17′, is less by 5 meters only than the arc intercepted on the ellipsoid of Clarke, the flattening, or departure from an ellipse, of which is 1 : 293.46. This shows that, taken altogether, the French arc is almost exactly the same as that of this ellipsoid.

5. The two stations which can be identified with those of the old meridian are Dunkerque and Carcassonne. The new arc between those stations exceeds the arc of Delambre by 44.7 meters, or about 1-20,000.

6. The geodetic co-ordinates have been calculated by starting from the base co-ordinates of the Pantheon, as newly determined by the Geographic Service, and by applying the line to the ellipsoid of Clarke, on hypothesis which has been justified by the facts given above.

7. The comparison of these calculated co-ordinates with the direct co-ordinates has been made at five stations, where the observers determined three elements—longitude, latitude and azimuth. According to a theorem of Laplace there exists a relation between the astronomic longitudes and azimuths and the same elements calculated geodetically, which ought to be verified if the observations are good, whatever the local attractions may be. In each of the five stations where the comparisons were made this equation of condition was satisfied within a limit of less than 1″—a remarkably close result.

To sum up, there is no doubt that the results furnished by this new meridian may be considered as presenting all the certainty attainable in a work of high precision.

A HORIZONTAL COMPOUND ENGINE.

The illustrations given, from *Industries*, show a compound engine of a somewhat peculiar type, built by the Maschinenbau Actien Gesellschaft, of Nürnberg, Germany. Fig. 1 is a longitudinal section through the high-pressure cylinder; fig. 2 a transverse section and fig. 3 a sectional view of the low-pressure cylinder and valve.

In this engine the steam from the boiler is led into the high-pressure steam jacket, where, after circulating around the cylinder, it is admitted into the cylinder covers. The admission valves are placed in the cylinder covers. They are of the central equilibrium type, each embracing a casting which forms an internal prolongation of the stuffing-box. The valves are worked by small rods projecting out parallel with the piston rods, and worked by rods controlled by trip gear. The high-pressure trip gear has the cut-off adjusted by the speed governor. The exhaust valves are also somewhat peculiar. They are of the gridiron type, and are actuated from the outside—that is to say, from the receiver side of the valve, being worked by a slide rod with two projectors, which passes through the exhaust chamber below the cylinder. This rod is worked by a rocker, which is actuated by the lower slipper of the cross-head. In fact, the gear we are accustomed to see on small pumps is here applied to a large engine. From the high-pressure cylinder the exhaust passes to the receiver. This is jacketed with high-pressure steam direct from the boiler. The receiver steam then circulates around the low-pressure cylinder, and afterward passes to the low-pressure valves, which are arranged as in the high-pressure cylinder, except that the governor has no action on the low-pressure trip gear, the cut-off being altered by hand. A condenser is used when convenient.

The cylinders are 15 in. and 22½ in. in diameter by 27½ in. stroke. In ordinary work the engine is run 70 revolutions per minute, and is supplied with steam at 100 lbs. pressure. When, with this initial pressure, the steam is expanded to twelve times its volume, the engine develops 80 H.P., and when expanded seven times it develops 120 H.P. The fly-wheel weighs about 4 tons, and is 11 ft. 6 in. diameter.

This engine was shown at the late Frankfort Electrical Exhibition, where it drove a Lahmeyer dynamo, which was utilized for transmitting power for pumping water for the fountains.

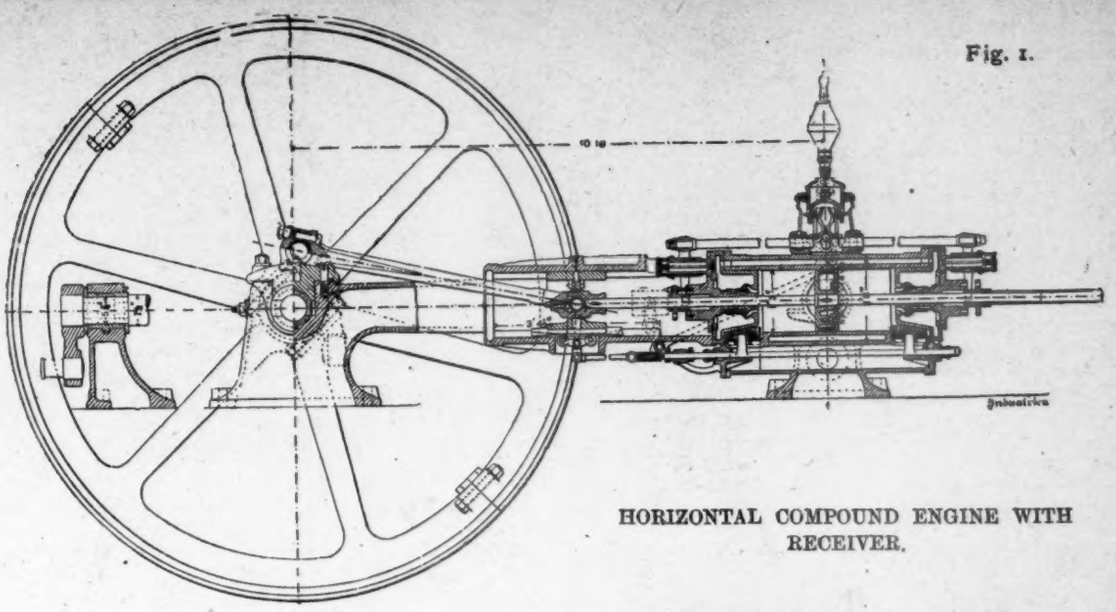
RAILROAD STATISTICS.

The Fourth Statistical Report of the Interstate Commerce Commission, prepared by its Statistician, has just been submitted. It comprises a text of about 100 pages, and contains many important summaries and comparisons pertaining to the operations of railroads. The report covers the fiscal year ending June 30, 1891, and its main points are well given in the excellent summary sent out by the Commission.

MILEAGE.

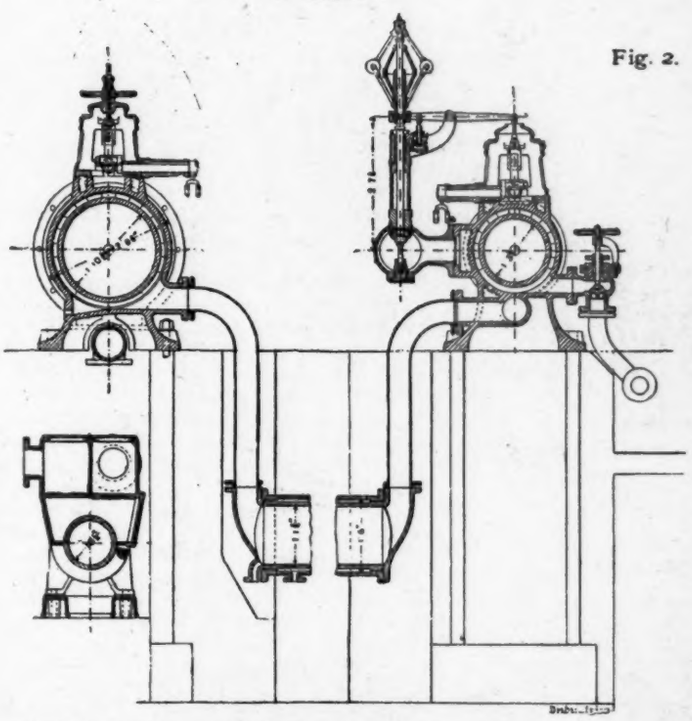
Railroad mileage in the United States on June 30, 1891, was 168,402 miles. This figure indicates the length of single track mileage, the total mileage of all tracks being 216,149 miles. The length of single track per 100 square miles of territory, exclusive of Alaska, was 5.67 miles, and the length of track per 10,000 inhabitants was 26.29 miles. Some of the States are exceptionally well provided with railroad facilities, as may be seen by the table of the report which shows the length of line in the several States per 100 square miles of territory. Such assignment shows for Con-

Fig. 1.



HORIZONTAL COMPOUND ENGINE WITH RECEIVER.

Fig. 2.



necticut 20.77 miles; for Delaware, 16.10 miles; for Illinois, 18.25 miles; for Iowa, 15.12 miles; for Massachusetts, 25.99 miles; for New Jersey, 27.71 miles; for New York, 16.19 miles; for Ohio, 19.68 miles; for Pennsylvania, 22.77 miles. The only countries in Europe which have an excess of 10 miles per 100 square miles of territory are Germany, with 12.77 miles; Great Britain, with 16.52 miles; France, with 11.23 miles; Belgium, with 28.71 miles; Holland, with 13.83 miles, and Switzerland, with 12.43 miles. No country in Europe, Sweden alone excepted, has 10 miles of line per 10,000 inhabitants; while in this country, on the other hand, but two States have less than 10 miles per 10,000 inhabitants.

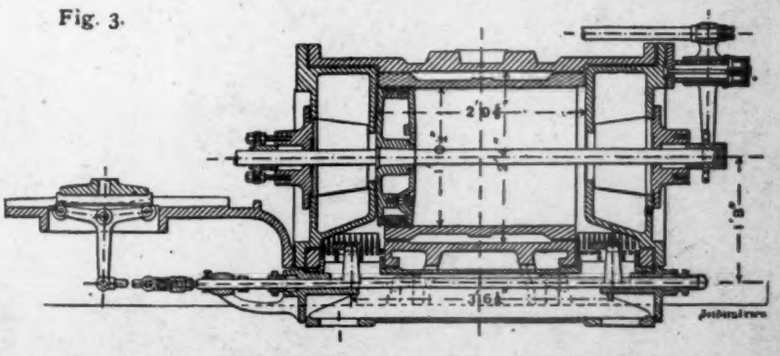
The increase in mileage during the year was 4,805 miles. This is less than the average of increase for several years past. The greatest activity in railroad building seems to have been in the States lying south of the Ohio and east of the Mississippi rivers, the total increase in these States being 1,670 miles. The steady increase of mileage in the Southern States during a year when there was general quiet in railroad building in the other parts of the country indicates a healthy development.

ORGANIZATION OF RAILROADS.

There were, at the close of the year, 1,785 railroad corporations, of which 889 were independent companies for the purpose of operation, and 747 were subsidiary companies, the remainder being private lines. The report further shows that 16 roads have been abandoned during the year, and that 92 roads, representing a mileage of 10,116, have disappeared by purchase, merger or consolidation. The actual number of railroad corporations in 1891 is less than the number which existed in 1890, notwithstanding the fact that a considerable number of new lines were chartered during the year. The tendency toward consolidation is clearly indicated by the report. On June 30, 1891, there were 42 companies, each of which controlled a mileage in excess of 1,000 miles, and nearly one-half of the mileage of the country is the property of these 42 companies.

Another classification contained in the report shows that there are 80 companies, each of which has a gross revenue in excess of three millions of dollars. The railroads of this class control 69.48 per cent. of the total mileage of the country,

Fig. 3.



receive 82.09 per cent. of the amount paid by the public for railroad service, and perform 83.76 per cent. of the total passenger service and 82.66 per cent. of the total freight service of the country. Out of a total of 81,073,784,121 tons of freight carried one mile, the railroads in question carried 67,008,448,436. Such figures as these in-

dicate the extent to which concentration of railroad control has proceeded in the United States.

EQUIPMENT.

The total number of locomotives used was 32,139, showing an increase of 1,999 during the year; and the total number of cars, the property of railroads, was 1,215,611, showing an increase of 45,944 during the year. The number of locomotives per 100 miles of line was 20; the number of passenger cars per 100 miles of line was 17; and the number of freight cars per 100 miles of line was 714.

The increase in equipment has not proceeded as rapidly as the increase in train brakes and automatic couplers. The increase in equipment during the year, including locomotives and cars, was 47,943, while the increase in the equipment fitted with automatic couplers was 53,716, and the increase in equipment fitted with train-brakes was 39,505. The estimated increase in equipment for the year 1892 is 29,821, while the estimated increase in equipment fitted with automatic couplers is 98,563, and the equipment fitted with train-brakes is estimated to have increased 96,503. These figures show clearly that at the present rate it will be many years before the total equipment will be fitted with safety devices unless Congress sees fit to take prompt action in the premises.

MEN EMPLOYED.

The number of men employed on railroads in the United States during the year covered by the report was 784,285, being an increase of 34,984. The number of men employed per 100 miles of line was 486. The report brings an interesting fact to light by showing that the number of men in the employ of the railroads in proportion to the total population was 1 to 87 inhabitants in 1889; 1 to 84 inhabitants in 1890; and 1 to 82 inhabitants in 1891. From this it will be seen that the population of the country increases at a less rapid rate than that portion of the population engaged in transportation by rail.

The extent to which organized industry has increased the efficiency of labor is shown by the fact that every engineer, during the year, has on an average carried 369,077 passengers one mile and 2,329,639 tons of freight one mile.

CAPITALIZATION AND VALUATION.

The total capitalization of the railroads of the United States is $9,829,475,015, or $60,942 per mile of line. This shows an increase in outstanding capital of $602 per mile of line as compared with the 1890 report. An analysis of the changes in capital outstanding shows that income bonds have increased from $76,933,818 to $324,288,690. A considerable portion of this increase is probably due to a conversion of stocks into income bonds. It is significant because it shows an increase in that form of property for the management of which directors are not held to strict responsibility. Equipment trust obligations have also increased from $49,478,215 to $54,755,157. A few years ago the opinion prevailed that the leasing of equipment by railroad companies was fast disappearing. This opinion is not supported by the facts.

EARNINGS AND EXPENSES.

The gross earnings from operation during the year ending June 30, 1891, were $1,096,761,395, or $6,801 per mile of line. Operating expenses were $731,887,893, or $4,538 per mile of line, leaving the net earnings from operation $364,873,502, or $2,263 per mile of line. The net earnings per mile of line were less than the net earnings of the previous year by $37. An analysis of gross income shows that freight traffic gave rise to $736,793,699, or 67.17 per cent. of total earnings; and that passenger traffic gave rise to $281,178,599, or 25.64 per cent. of total earnings. The amount received from carrying mail was $24,870,015, and the amount received as rentals from express companies was $21,594,349. The analysis further shows that $133,911,126 were received as income from investments. The assignment of operating expenses shows that 34.08 per cent. is chargeable to the passenger service and 65.92 per cent. to freight service. The percentage of operating expenses to operating income was 66.73 per cent. The number of passengers carried during the year was 531,183,988; the number carried one mile was 12,844,243,881. The number of tons of freight carried was 675,608,323; the number carried one mile was 81,073,784,121. The total number of miles run by passenger trains was 307,927,928, and the number of miles run by freight trains was 446,274,508. The average journey per passenger was 24.18 miles, and the average haul per ton of freight was 120 miles. The average number of passengers in a train was 42, and the average number of tons of freight in a train was 181.67. The average revenue per passenger per mile in 1891 was 2.142 cents, and the average revenue per ton per mile was 0.895 cent. The average revenue per train mile, passenger trains, was 106.111 cents, and the average revenue per train mile, freight trains, was 163.683 cents.

RAILROAD ACCIDENTS.

In narrating the statistics of accidents, the report shows that casualties during the year ending June 30, 1891, are greater than in any previous year covered by reports to the Commission. The number killed during the year was 7,029, and the number injured was 33,881. Of these totals, the number of employés killed was 2,660, and the number injured was 26,140. The number of passengers killed was 293, and the number injured was 2,972. A classification of casualties according to the kind of accident shows 415 employés were killed and 9,431 injured while coupling and uncoupling cars; 598 were killed and 3,191 injured falling from trains and engines; 78 were killed and 412 were injured from overhead obstructions; 303 were killed and 1,550 were injured in collisions; 206 were killed and 919 were injured from derailment of trains; 57 were killed and 319 were injured from other accidents to trains than collisions and derailments already mentioned; 20 were killed and 50 injured at highway crossings; 127 were killed and 1,427 were injured at stations; the balance, which makes up the total of 2,660 killed and 26,140 injured, is due to accidents which do not naturally fall in the classification adopted for report. Referring to passengers, 59 were killed and 623 injured by collisions; 49 were killed and 837 injured by derailments; 2 were killed and 34 injured by other train accidents; the balance, making up a total of 293 killed and 2,972 injured, being assignable to accidents at highway crossings and at stations and to other kinds of accidents.

This report emphasizes more strongly than previous reports the necessity of legislation compelling railroads to adopt train brakes and automatic couplers, and also suggests that some steps be taken besides the adoption of the train-brake to prevent the frequency of casualties from falling from trains and engines. The large number killed and injured from collisions also brings prominently into notice the necessity of some extensive use of the block system in the handling of trains and a more perfect application of the principle of personal responsibility in the case of accidents. An investigation into the matter of handling trains is recommended by the report. Not only are the accidents of the year covered by this report greater than those of previous years, but, when compared with the increase in employés, it is observed that they are relatively greater than those of the previous year. Thus, during the last year 1 employé was killed for every 296, and 1 employé injured for every 30 men in railroad service. The corresponding figures for the previous year are 1 man killed for every 306, and 1 man injured for every 33 employés. This same fact is also presented in another manner. The increase in the number of employés killed during the year covered by the report over the previous year is 9 per cent., and the increase in the number injured is 17 per cent., while the increase in the number of men taken into employment is less than 5 per cent. The corresponding comparison for casualties to passengers shows that, while there has been a relative decrease in the number of passengers killed, the number of passengers injured shows a much greater increase than the increase in the number of passengers carried. On the whole, the comparison of accidents for the two years leaves a very unsatisfactory impression, since it shows that liability to accidents

was greater during the year covered by this report than during the previous year.

RECOMMENDATIONS.

The report concludes with a recommendation for certain amendments to the Interstate Commerce Act, which, it is asserted, are necessary to render the statistics of the business of transportation complete and satisfactory. Thus, it is recommended that express companies and water carriers engaged in interstate traffic be required to make reports to the Interstate Commerce Commission similar to those now made by railroads, and that persons, companies or corporations owning rolling stock used in interstate traffic should be obliged to make annual reports so far as may be necessary for a complete statement of the kind of rolling stock used by railroads.

THE DRAINING OF THE ZUYDER ZEE.

(Note by J. de Koning, presented before the French Society of Engineers.)

For some time past, since the death of Chief Engineer Van der Toorn, the project for draining the Zuyder Zee has been in charge of Mr. Lely, who has finally completed the plans for the work, and who has reached some new conclusions. He admits that the building of a dike across the Zuyder Zee by way of the islands of Texel and Vlieland is not practicable, as the bottom is there composed of shifting sand. The plan originally proposed being thus laid aside, the substitute brought forward is the construction of a great dike from the shore of the province of Holland to that of Friesland by way of the island of Wieringen. The sea being shut out by this main dike, four subordinate dikes will then be built, each enclosing a section of land to be grained, and in the center will be left a lake, to be called Lake Yssel, which will receive the waters of the Yssel River, and will communicate with the sea by several locks.

The building of the main dike will assist very much in the construction of the subordinate ones, the height of which will be much less than would be required if they were exposed to the open sea. The lake will serve as an intermediate reservoir in which the waters of the various streams will be collected, and there will be no necessity for pumping.

The accompanying sketch map shows the general nature of the plan, the four areas of land to be drained being shown by the cross-lined sections.

The length of the main dike will be about 18½ miles. A coffer-dam will be built up to low-water mark, and behind this will be raised a bank of sand, covered and protected by a thick layer of clay, which will be well rammed down, and in its turn will be protected by riprap. The dike will be built up to a height of 16½ ft. above ordinary high tides: this will make its height from the bottom from 30 to 35 ft. It will be on an average 300 ft. thick at the base.

Great care will be necessary in constructing the final portion, when unusually high tides or storms may force a great mass of water from the sea into the Zuyder Zee through a comparatively small opening.

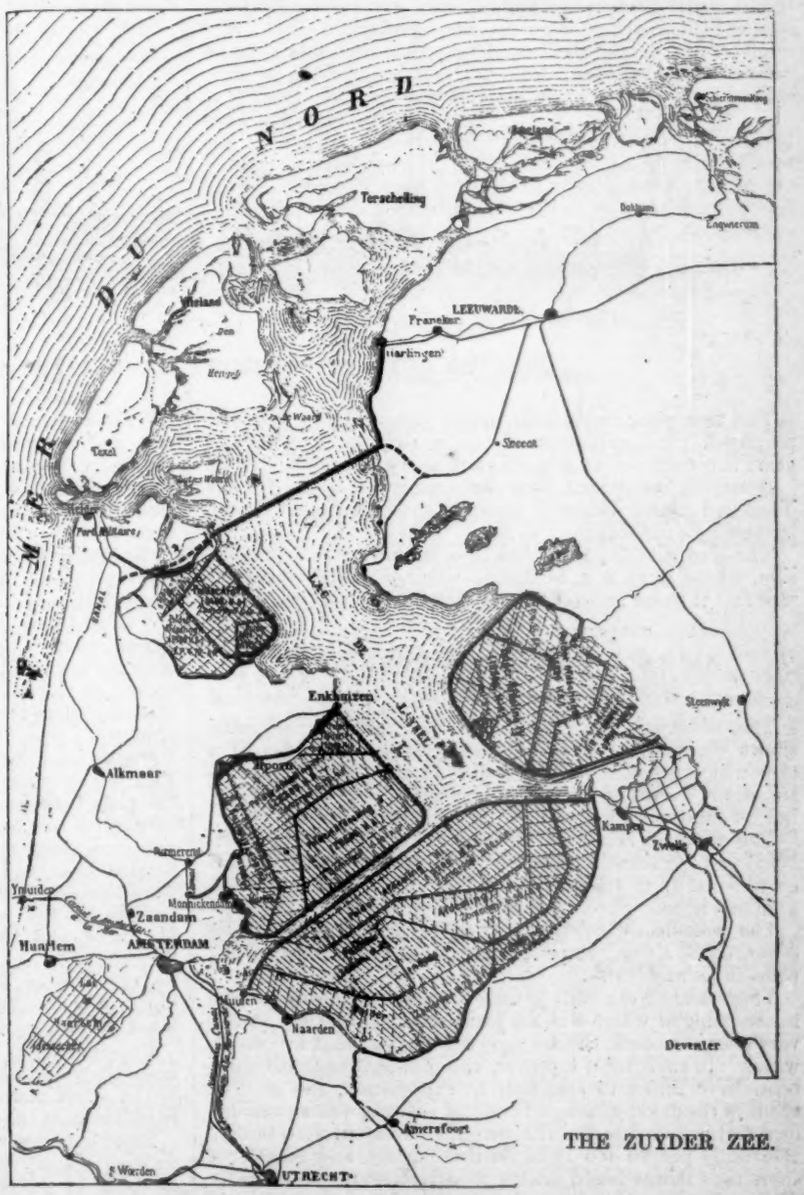
The building of the dike will take about eight years. This time cannot be much shortened, because of the great number of fascines and the quantity of stone which will have to be provided. Its estimated cost is about $17,000,000.

Even if the land drainage works should not be carried out, it is believed that this dike will be a useful work, for the following reasons:

1. The provinces behind the dike will be fully protected from inundation by the Zuyder Zee.
2. The cost of maintaining the present shore dikes will be greatly diminished.
3. The constant level of the water enclosed by the dike will secure a free and even flow of the streams discharging into it from the surrounding country.
4. The enclosed lake would be of fresh water, which could be used for irrigating the polders, or meadows, in dry seasons.
5. The dike itself would form a short and convenient road between two important sections of the country.

The dike, being provided with tide-locks of ample size, will give full facilities for navigation, and the fisheries will be the only interest which can be injured. It may be said, however, that the advantages presented above would be hardly sufficient to justify the expenditure, and the land drainage part of the plan must be considered.

The area behind the dike will be about 900,000 acres, of which 580,000 acres are to be drained. After making deductions for roads, canals, etc., there will be left about 540,000 acres of farming land. Careful examination and estimate shows that of this 71 per cent. will be excellent land, 19 per cent. moderately good, and only 10 per cent. poor.



THE ZUYDER ZEE.

The drainage of the land will be effected by building a dike around each section, and then pumping the water into Lake Yssel. As the work proceeds roads and canals will be built and the ground laid out into suitable lots.

The cost of the drainage is estimated at $63,000,000. Adding to this $17,000,000 for the main dike, makes the total cost $80,000,000, or about $148 per acre to be reclaimed. Interest on capital during construction and other charges will raise the cost to about $160 per acre.

The first step will be the building of the main dike. When that is completed the work of draining the four areas to be reclaimed will be begun and gradually carried out. The entire work will require about 30 years for its completion. The drainage will proceed slowly in order to reduce to a minimum the danger from malarial fevers, which might arise from the exposure of too great a surface of new land. After 10 years the sale of land might commence, probably not more than 25,000 acres a year being put on the market at first. This quantity, it is believed, would be readily taken up without affecting the value of the remaining area. The total area of land will nearly double the extent of arable land in Holland.

The new plan meets many objections made to that first proposed. The extension of the work over a number of years is considered an advantage in many respects.

It may be mentioned that communication between Lake Yssel and Amsterdam will be established by a canal, which is shown on the map.

The plan outlined above has been submitted to a commission, whose duty it is to decide whether the Government will find it to its interest to undertake the work.

AN ENGLISH TORPEDO CRUISER.

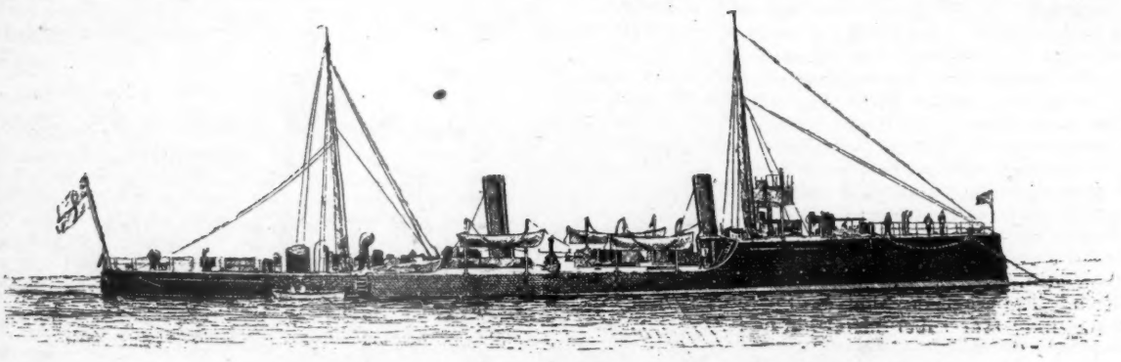
THE illustration given herewith is from *Le Yacht*, and shows the English torpedo-chaser *Speedwell*, a vessel of a type which is not as yet represented in our Navy. The construction of a ship of this class was authorized by Congress, but no contracts were ever let for its construction.

The *Speedwell* is one of thirteen, and is 230 ft. long, 28 ft. beam and 748 tons displacement. Her engines were intended to work up to 4,550 H.P. and to give her a speed of 21 knots an hour. She can carry 100 tons of coal.

The armament consists of two 4.7-in. rapid-fire guns, four 3-pdr. guns, a fixed torpedo-tube at the bow, and two torpedo-tubes amidships.

These boats were built to take the place of an earlier class the working of which was not satisfactory, since they proved very poor sea boats, though showing a high speed in smooth water. In their turn, however, the *Speedwell* and her sister boats have failed to come up to expectation, and some of them in the naval manœuvers of last year showed an amount of structural weakness which was not consistent with safety. The hulls proved too light for the engines, and even for a short time it was found unsafe to drive them over 17 knots an hour. One or two of them, after short runs at high speed, were found to leak to a dangerous extent.

A new lot of 11 of these torpedo-gunboats has recently been begun, but they will, while having the same length and beam, be given a little more depth and 810 tons displacement. The extra weight will be used to strengthen the hull. Moreover, the engines will be lighter—about 3,600 H.P.—and the speed will not exceed 19¼ knots. The engines of the present ships will probably be used for a larger class, having about 250 ft. length, 30 ft. beam and 1,100 tons displacement.



TORPEDO GUNBOAT "SPEEDWELL," FOR THE ENGLISH NAVY.

RIVETED JOINTS.

By H. deB. Parsons.

ALTHOUGH the strength of riveted joints has been discussed by many authors at considerable length, there still appears to be much misunderstanding in regard to them. Most of the experiments have been made on the thinner plates, while the present tendency is to use thicker plates of steel with drilled holes and power driven rivets. The proportions, as deduced from the earlier experiments, in consequence, do not hold true for these thicker plates, as the rivets would be of such large diameters as to be difficult and dangerous to rivet even with the most modern riveters. To-day the diameters of rivets suitable for the thicker plates are generally determined by practice and the size of the riveters in use rather than the rules laid down by theory.

Sir William Fairbairn deduced from experiments on ½-in. and ⅝-in. plates that the proportion of strength of the whole plate to that of the joint was in the ratio of 100 to 70 and 100 to 56 for double and single riveting respectively. Comparing many of the later experiments, these proportions appear too high and further from the truth as the plates increase in thickness. Another error is caused by using a shearing strength for the rivet as equal to the tensile strength. One of our best-known boiler works uses this strength for shearing, but proportions its joints so that the shearing strength of the rivets shall exceed the strength of the plate between the rivet holes in the proportion of about 13 to 8 for iron rivets, and of 28 to 23 for steel rivets. Iron rivets are much more extensively used for boiler work at the present time, and, from a large number of tests examined, the shearing strength for them should not be taken to exceed 40,000 lbs. per shearing area in square inches for single shear, and 35,500 lbs. for double shear. There is no doubt that in certain cases the friction of the plates, caused by the grip of the rivets, assists the shearing strength; but as this does not always occur, it cannot be relied upon when proportioning so important a joint as that of a boiler.

Experiments on the strength of boiler plates between the holes show an increase of strength per square inch over that of the whole plate, as might have been expected, since the parts between the holes act like short specimens.

From experiments made by Professor A. B. W. Kennedy on steel plates,* this apparent increased strength amounts to about 11 per cent. of the strength of the plate when the holes are drilled. On account of the great difficulty in

* *Transactions*, Institute of Mechanical Engineers, 1881.

RIVETED JOINTS.

LAP OR BUTT WITH SINGLE WELT.—STEEL PLATES AND IRON RIVETS.

Thickness of Plates.	Diameter of Rivets.	Pitch.		Efficiency.	
		Single.	Double.	Single.	Double.
¼″	½″	1 3/16″	1 7/8″	55.7 %	70.0 %
5/16″	3/4″	1 11/16″	2 1/16″	52.7 "	68.6 "
3/8″	7/8″	1 7/8″	2 1/4″	49.0 "	65.9 "
7/16″	7/8″	1 11/16″	2 7/16″	43.6 "	60.4 "
1/2″	1 "	1 7/8″	2 5/8″	42.0 "	59.5 "
9/16″	1 "	1 3/4″	2 15/16″	38.6 "	55.4 "
1″	1 1/8″	2 1/16″	2 5/8″	38.1 "	54.9 "

properly matching the holes, and of the stress caused by forcing, as is too often the case in practice, this additional strength cannot be trusted much more than that of friction.

Adopting the sizes of iron rivets as generally used in American practice for steel plates from ¼ to 1 in. thick; the tensile strength of the plates as 60,000 lbs.; the shearing strength of the rivets as 40,000 for single shear and 35,500 for double shear, I have calculated the accompanying table of pitches, so that the strength of the rivets against shearing will be approximately equal to that of the plate to tear between rivet holes. The diameter of the rivets has in all cases been taken at 1/16 in. larger than the nominal size, as the rivet is assumed to fill the hole under the power riveter.

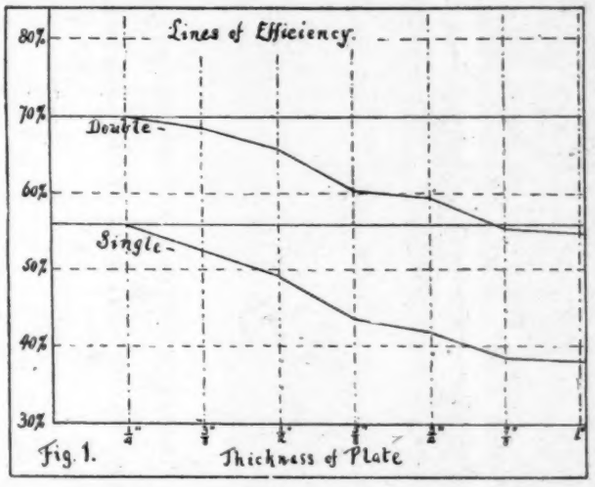


Fig. 1.

In fig. 1 I have laid out the lines of efficiency of the joints as calculated from the above data for both double and single riveting; the straight horizontal lines representing Fairbairn's relative strengths as a means of comparison.

Comparing the proportions of joints as used in many boiler shops, it will be seen that the joints are still less efficient than the above, and in many important boilers with ⅞ and 1-in. plates, the proportional strength is only 30 per cent., and less of that of the plates.

When the exact tensile strength is known, and still using 40,000 lbs. as the shearing strength, the calculated results compare very favorably with the actual results of experiment, usually not exceeding 5 per cent. difference. From tests made by the U. S. Board on "Iron and Steel," 1882, I find as an example for ½-in. steel plate, five ⅝-in. iron rivets at 2-in. pitch, the fracture took place by shearing, showing an actual efficiency of 48.2 per cent. against 53 per cent. calculated. With ⅜-in. plate, 11/16-in. rivets in punched holes, at 2-in. pitch, the rivets sheared, showing an actual efficiency of 45.4 per cent. against 45.6 per cent. calculated. The same is true for double-riveted joints; for instance, from the same report I find for ½-in. steel plate ⅝-in. rivets at 2-in. pitch, the plate fractured between the holes, showing 74.9 per cent. efficiency. The calculated efficiency was 70.8 per cent. if we add the 11 per cent. for apparent increased strength. And, again, for a ⅜-in. plate with 11/16-in. rivets in punched holes at 2-in. pitch, the plate fractured between holes, with 63.8 per cent. efficiency, having a calculated efficiency of 60.4 per cent. and 64.6 per cent. if we add the 7 per cent. increased strength as found by Fairbairn for punched plates.

Owing to the unevenness of the joint in practice, and the liability of damaging the plate between the holes by the use of the drift-pin—which even the most rigid specification does not seem to prevent—and by punching and insufficient reaming, the strength of the plate at the joint will decrease, but this decrease will be partially offset by the 11 per cent. additional strength above referred to. On the other hand, the shearing strength, as used plus the friction, is the maximum for the rivets, and as the holes never truly match for the whole length of the joint, the shearing area will be reduced accordingly; so that we may conclude that for boilers built with care the above proportions for plate and rivet strength will remain about equal. In practice it would be advisable to slightly increase the pitch, as given in the table, so as to allow for some of the holes to be reamed out in case they do not match, and also to allow for a reduction of the plate by wear, thereby sacrificing a little of the efficiency. But I see no reason why, with the size of rivets as used, the pitch should be as large as it is, which greatly diminishes the strength.

For the thicker plates the rivets should be larger to obtain a higher efficiency, but, owing to practical difficulties, larger rivets cannot be used successfully. There is, however, no good reason why the pitch should remain the same as if these larger rivets had been employed, and yet such is the common practice.

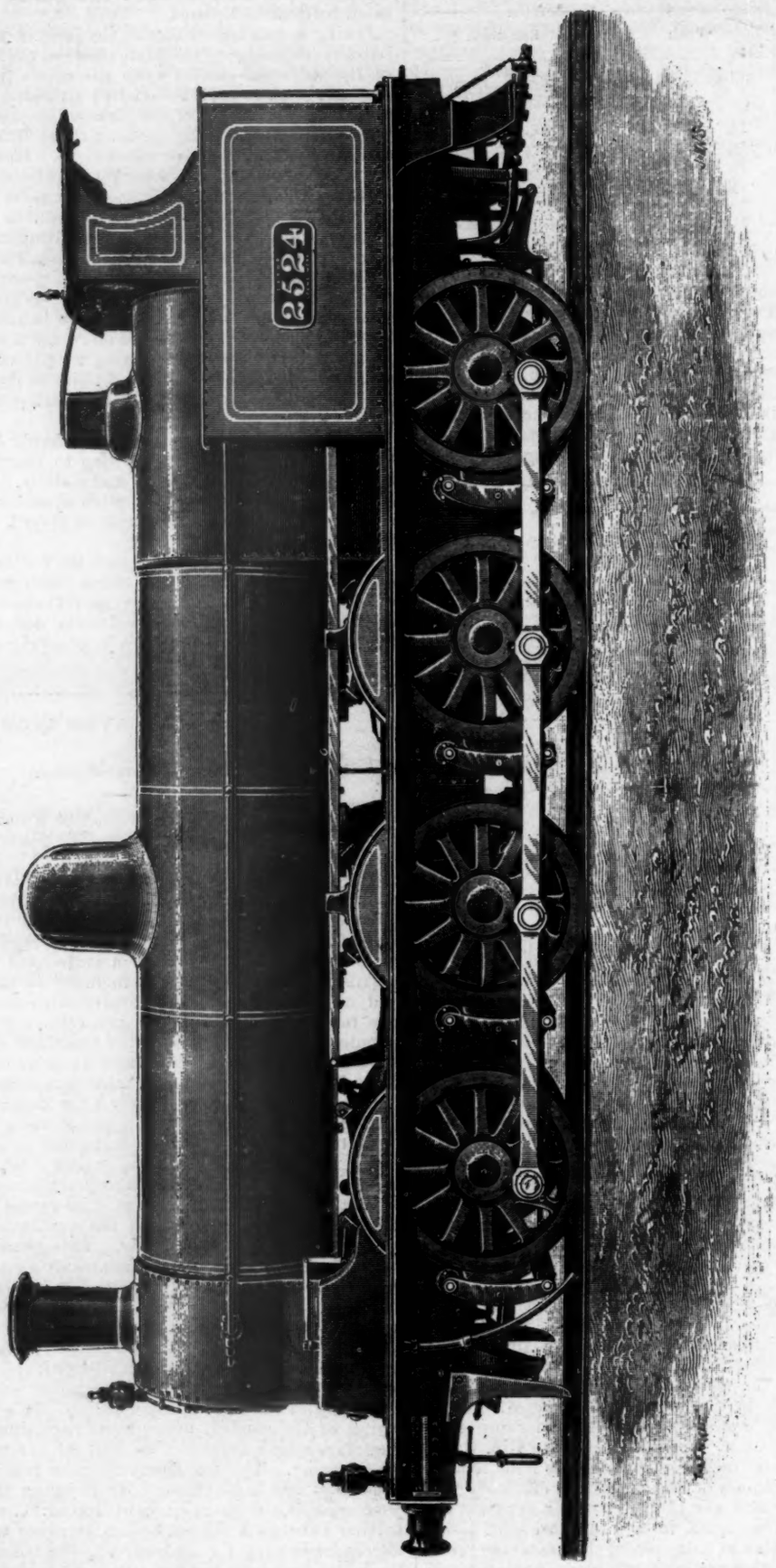
I have seen some boilers which the builders claimed had a factor of safety of six, but which really had only a factor of two. In such cases the extreme refinement of testing the sheets for tensile strength is valueless, and the time would have been much better spent in rearranging the proportions of the joint.

THE DELHI WATER WORKS.

(From the *Indian Engineer*.)

THE new water works at Delhi, which were designed and carried out by Mr. Parkes as Chief Engineer, were formally opened November 4.

The works, which were begun in the early part of 1890, are calculated to supply an average of 10 galls. a day for a population of 173,000, equal to a total daily supply of 1,730,000 galls. It may here be mentioned that 10 galls. of water are about equal to a large-sized *mussuck*. The population to be supplied is included in the city, the fort and cantonments, and in the civil lines and suburbs. Of the total quantity about 70 per cent. will go to the city population. So far only half the estimated number of wells have been sunk. This was done in order to determine accurately the absolute number that would eventually be required for the complete supply; the method of obtaining filtered water from a river by a line of wells in close proximity to the running stream being unique in India. The number of wells constructed up to date is 43, the total daily supply obtained from them during the month of June last, when the water in the river was at its lowest level, hence at the most unfavorable season of the year, was 872,000 galls. in an ordinary day's pumping. This quantity is equal to about three-fourths of the full allowance for the city. With the completion of the wells the full supply for the city will be obtained, as well as that for the suburbs and cantonments. The water is led from the wells to the engine-house by a 3-ft. conduit, 500 ft. in length, consisting partly of brick masonry and partly of cast-iron pipes, imbedded in concrete. The majority of these pipes were successfully cast in Delhi at Bhana Mal and Gulzari Mal's foundry. The laying of the conduit under water necessitated continuous pumping, which delayed this part of the operations very considerably. The machinery used for pumping the water consists of two high-pressure Worthington triple-expansion jet-condensing engines, each of 100 H.P., and two multitubular Babcock & Wilcox boilers, together with two economizers for heating the feed-water to the boilers by means of the waste heat from the furnaces. Each engine, boiler and



LOCOMOTIVE FOR COAL TRAFFIC, LONDON & NORTHWESTERN RAILWAY.

DESIGNED BY F. W. WEBB, LOCOMOTIVE SUPERINTENDENT; BUILT AT COMPANY'S SHOPS, CREWE, ENGLAND.

economizer is capable of raising, separately and independently, 1,750,000 galls. of water in 16 hours from the well underneath the engine-house, and forcing it through 6,000 ft. of rising main 18 in. diameter to the reservoir, the total vertical height being 140 ft.

The reservoir is built on the highest point of the ridge, immediately to the east of Hindu Rao's house. The top water level in the reservoir is 90 ft. above the average level of the city. The dimensions of the reservoir are 300 ft. in length and 150 ft. in breadth, and when full it will have a depth of 10 ft. of water. The cubical capacity is over 2,500,000 galls., equal to 1½ days' supply for the whole population. The inside of the reservoir has been plastered with a thin coat of Portland cement, in order the more effectively to scour and clean it out on occasions when this has to be done. The walls of the reservoir are constructed of stone masonry, and the roof consists of concrete arches, the whole being covered in with earth to keep the water cool. The water can, at any time, when required, be pumped direct into the city main through a by-pipe, without passing through the reservoir.

From the reservoir to the city the water flows through a main about 8,000 ft. long. This main has a diameter of 24 in. as far as the canal crossing. In order to permit of the extension of the system to the suburbs of Delhi, three branch pipes take off in this length, one for the Sabzimandi, the second for the civil lines, and a third to supply the suburbs of the Sadar Bazaar and Paharganj. From the canal crossing to the Lahore Gate of the city the main is reduced in size to 21 in. diameter. Within the city the total aggregate length of piping is 111,500 ft., rather more than 21 miles, varying in diameter from 18 in. to 3 in. This piping supplies all the intramural population, exclusive of the fort, the cantonment at Dariaganj, and the railroad station. Hydrants have been erected along every line of main piping, at intervals of 200 to 400 ft., according to the density of the population. To facilitate the extension of the pipe system, and to permit of the eventual introduction of house-connections in every street and *guli*, extra branch pipes have been provided, where necessary, on all the mains. The total estimated cost of the works is about $500,000, of which $440,000 have been expended up to date.

THE LATEST ENGLISH FREIGHT LOCOMOTIVE.

THE illustration given herewith, from the London *Engineer*, shows a new type of freight locomotive designed by Mr. F. W. Webb, Locomotive Superintendent of the London & Northwestern Railway, for working the heavy coal traffic on that road.

The boiler is of the pattern devised by Mr. Webb and used by him in his latest compound engine, the *Greater Britain*.* The tubes are divided into two lengths by a

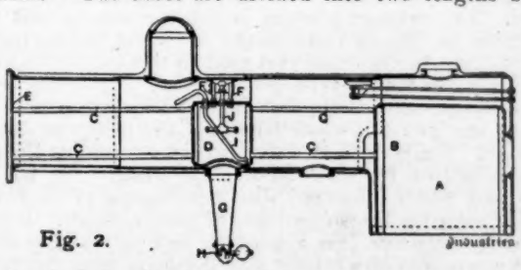


Fig. 2.

combustion chamber; the back group, extending from the fire-box to this combustion chamber, being 4 ft. 10 in. long, and the front group, from the combustion chamber to the smoke-box, being 8 ft. 1 in. long. This makes an unusually long boiler. The barrel is 51 in. in diameter and 15 ft. 6 in. long; the outside fire-box is 6 ft. 10 in., making the total length of boiler 22 ft. 4 in. There are 156 tubes 2¼ in. in diameter, the lengths being given above. The grate area is 20.5 sq. ft.; the heating surface is: Fire-box, 114.7; combustion chamber, 39.1; back tubes, 408.5; front tubes, 683.0; total, 1,245.3 sq. ft. The boiler is built for 160 lbs. working pressure. Fig. 2, which is from Mr. Webb's patent specifications, shows the general design of the boiler.

The cylinders are inside and are 19½ in. in diameter and 24 in. stroke. The steam-chests are above the cylinders, and the valves are worked by Joy's gear.

The wheels, which are all coupled, are 53½ in. in diameter. The leading and trailing wheels have ½ in. side play in the axle-boxes. The axles are at equal distances, 5 ft. 9 in., making the total wheel-base 17 ft. 3 in. The springs on the first three pairs of wheels are equalized; the trailing wheels have an ordinary cross spring. Each coupling rod is complete in itself, and they are arranged so as to be interchangeable.

The total weight of this engine in working order is 104,900 lbs., which is distributed as follows: Leading wheels, 26,100 lbs.; main driving-wheels, 28,400 lbs.; third pair, 26,100 lbs.; trailing-wheels, 24,300 lbs. The weight of the tender in working order is 56,000 lbs.

The crank-axle bearings are 9 in. long, and there is a central frame carrying a 5½-in. bearing on the driving axle which is intended to assist in taking up the stress due to the connecting rods. The crank-axle bearings have thus a total length of 23½ in.

This engine is of unusual size, the great majority of English freight engines having six coupled wheels. In fact, the *Engineer* says: "This is, we believe, the first eight-coupled locomotive engine having a tubular boiler made in this country."

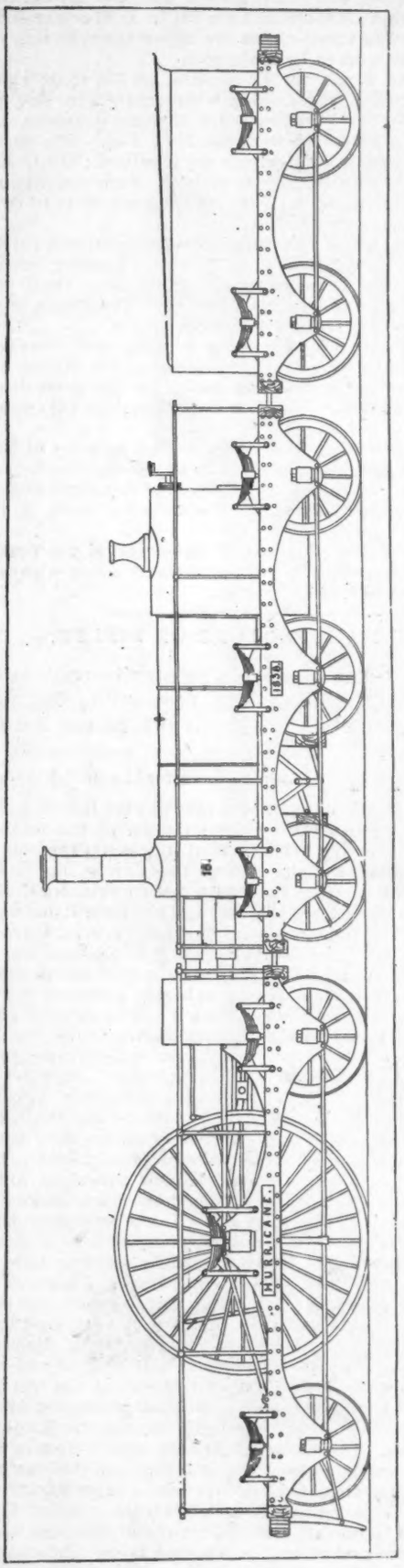
It may be added that the Webb boiler in the *Greater Britain* has now been in regular use over a year with very satisfactory results.

* See the RAILROAD AND ENGINEERING JOURNAL for January, 1893, page 18; and for April, 1893, page 196.

THE MANUFACTURE OF RIFLES.

WE give below an abstract of a paper read recently before the English Institution of Civil Engineers by Mr. John Rigby, Superintendent of the Enfield Rifle Factory, describing the manufacture of the Lee-Metford magazine rifle of 0.303 in. caliber, the weapon adopted for the British Army:

The most important part of a rifle was the barrel, which had always engaged the special attention of gun-makers. Up to the time of the Crimean War, it was, for the bulk of British troops, a comparatively rude tube of iron, lap-welded under rolls and tapering externally, with a cylindrical bore of about ¾ in. diameter. The barrel of the present day was a steel tube of accurate workmanship, only 0.3 in. bore, almost perfectly true and straight, rifled to $\frac{1}{2000}$ in., and so closely inspected that the existence of the most minute crack or seam in the bore, requiring a highly practised eye to detect it, was sufficient to condemn it. The material used was produced either by the Siemens-Martin or the crucible process of manufacture, and was supplied to Enfield as a solid round bar 1⅝ in. diameter and 15½ in. long. After severe testing, this bar was passed through a rolling-mill to draw it to its full length; it was then taken to the forge, the swell at the breech-end was stamped to the required shape by a steam-hammer, and afterward straightened cold. The next step was to submit the bar, without annealing, to the turning and drilling-machines. The latter were horizontal, the drills operating from each end. In the process of drilling, the barrel revolved at nearly 1,000 revolutions a minute against half-round bits held flat down, a capillary tube, of brass, supplying a soap-and-oil emulsion, at a pressure of 80 lbs. to the square inch, to wash out the swarth and cool the cutting-edge. The drills advancing from each end continued boring until a small disk about 0.01 in. diameter broke out, and the two holes met. The tendency of the drills to follow the line of axis of a revolving bar was one of those curious occurrences in practical mechanics which might be accounted for after observation, but which no one would predict. Occasionally, through some defect in the steel, a drill wandered from the axial line; in this case the barrel was taken from the machine and reset sufficiently to bring the hole true again. To test its truth, a ray of light was made to illuminate the flat bottom of the hole while the barrel slowly revolved. It was very rarely that a barrel was rendered waste from bad drilling. Rough boring followed with a three-edged bit, the blade being about 4 in. long. The rough external turning was effected in self-act-



LOCOMOTIVE "HURRICANE," WITH 10-FT. DRIVING WHEELS; GREAT WESTERN RAILWAY, OF ENGLAND.

BUILT BY HAWTHORNE & COMPANY IN 1838, FROM DESIGNS OF T. E. HARRISON.

ing lathes, which gave the required curved taper. Three or four cutters acted simultaneously, each producing a long cutting that attested the quality of the metal of the barrel. The operation of barrel-setting followed. Previous to rough-turning, the barrels were fairly straight internally, but the removal of the metal caused slight inequalities which were tested by the eye of the barrel-setter, and corrected by transverse blows. This constituted skilled labor of a peculiar character, and was performed by young men of good sight, who were specially trained for the purpose. After middle life the eye generally lost some of the quality necessary for this work, and it was rare to find a man excel in it after that period. Many mechanical devices had been contrived to supersede the simple ray of light laid, as if it were a straight edge, along the surface of the bore; but the eye still remained the arbiter of straightness, and could be relied on for very accurate results. The construction of the barrel was completed by the important operation of rifling. In British small-arm factories the system was followed of planing out each groove separately with a hooked cutter, and had been brought almost to perfection. In Continental and American factories the grooves were ploughed out by cutters, with several cutting or knife-edges set at an angle and following one another in the manner of a single-cut file or float. Similar machines had been tried at Enfield, but did not give as smooth a cut as the slower-moving, single-tooth machines. A few passes of a lead lap, fed with fine emery, removed any burr that might remain, and completed the polish; a cylindrical lap, spinning rapidly, was then passed through, and gave the final finish to the barrels. The limits of gauging were from 0.303 to 0.305 in.

Next in importance to the barrel was the mechanism of the breech, for which the material preferred was crucible cast steel of a mild character, but capable of being hardened in those parts exposed to the pressure of the bolt. The body was forged in two operations under the steam-hammer; it was then drilled and subjected to a long series of operations, in the course of which the end was recessed to receive the screwed end of the barrel, and the corresponding thread in the recess was milled out in a specially contrived machine, which insured that the thread should always start in the same place relative to the gauged part of the body, a point of great importance. The bolt, also of crucible cast-steel, was forged under the steam-hammer. A special machine, invented at Enfield, was used to finish the bolt after shaping. After machining, the bolts, packed in wood charcoal in iron cases, were heated and hardened by immersion in oil. The temper of the handle was then reduced in a lead bath. The rest of the bolt was tempered straw-color. The bolt-head was similarly hardened and tempered.

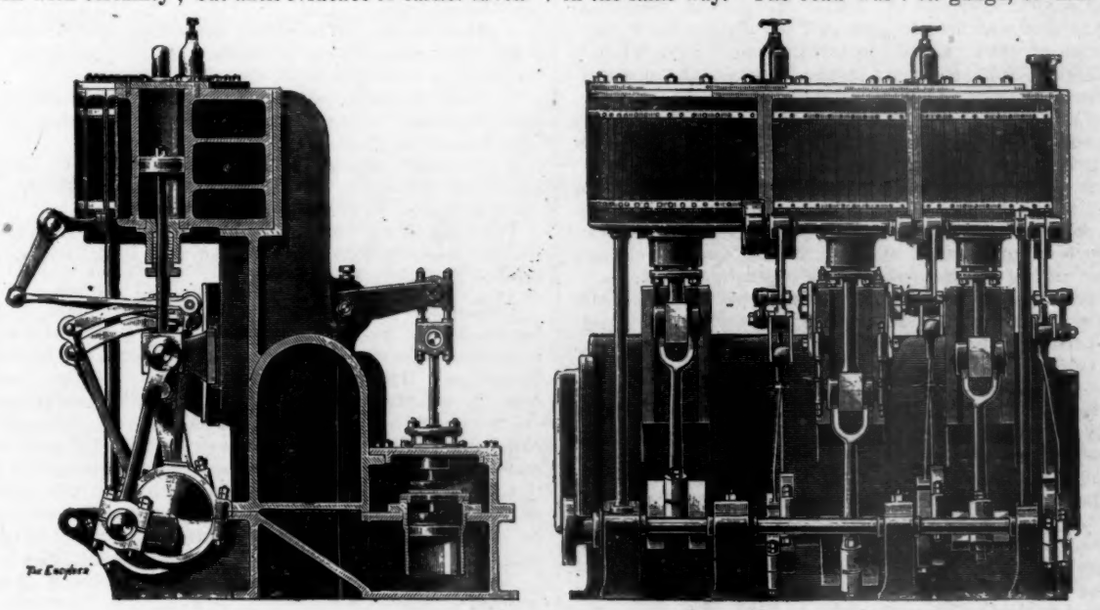
The other components of a complete rifle were mostly shaped by mills built up to the proposed profile, or by copy-milling machines. The process of drifting was used with good results at Enfield. All such slots or perforations as had parallel sides, and were not cylindrical, were so finished. The common practice in drifting was to push the drift, but at Enfield much better work was accomplished by pulling. It was found that used in this way drifts were very valuable for interchangeable work. The sides were cut with successive teeth, each slightly larger than the preceding one, and the whole length of the drift was drawn through. Emery wheels were also largely used at Enfield as a substitute for finish-milling and filing. The wheels ran under hoods connected with a pneumatic exhaust that carried away the heated particles of steel and grit. It was popularly supposed that a machine once adjusted to turn out a component of a certain size and shape was capable of reproducing such in large numbers, all absolutely identical. This was so far from being the case that no die, no drill, and no milling-cutter actually made two consecutive articles the same size. The wear of the cutters or dies proceeded slowly but surely, and it was only possible to produce in large numbers components of dimensions varying between a superior and an inferior limit. In small-arm manufacture a variation of about one two-thousandth of an inch was about the amount tolerated, but it varied according to the size of the piece. A difference of diameter of one two-thousandth of an inch in the sight axis-hole, and in the size of the pin or axis, would cause a serious misfit, whereas a similar difference in the measurement of the magazine, or

of the recess in which it lay, would be quite immaterial. The operations of gauging, proving the barrel, and sighting, were successively described, as also the manufacture of the stock, which was of the wood known as Italian walnut, though largely grown in other countries. Among the smaller components, the screws were mentioned as being rapidly produced by the automatic screw-making machines of the Pratt & Whitney Company.

The Component Store received the various finished parts, which numbered 1,591, or, including accessories, 1,863, and issued them to the foreman of the assembling-shop. Theoretically, the assemblers should have nothing to do but to fit and screw them together, but in practice small adjustments were found necessary. The amount of correction was generally exceedingly small, and was done wherever possible with the aid of emery wheels. The completed arms were submitted to inspection, and then issued in cases of 20 each to the Weedon Government Store or elsewhere.

THE FIRST TRIPLE-EXPANSION MARINE ENGINE.

THE London *Engineer* says: "Who invented the modern triple-expansion marine engine? We cannot answer the question with certainty; but until evidence of earlier invention is produced, we think that Messrs Russell, Spence & Company, of Glasgow, may claim the honor. The engine which we illustrate herewith is to all intents and purposes the same as the modern marine engine, and it was designed before the *Propontis* and *Aberdeen* were heard of."



THE FIRST TRIPLE-EXPANSION MARINE ENGINE.

We reproduce the illustration here. The *Engineer* does not give the date of the design, nor does it say when the engine was built. If it was really the first triple-expansion, it is of interest from that fact alone, and also as showing that in later designs there has not been very much variation from the original type, as the *Engineer* intimates.

THE LOCOMOTIVE WITH THE LARGEST DRIVING-WHEELS.

THE drawing given herewith, which is from a blue print forwarded to us by Mr. Clement E. Stretton, of Leicester, England, shows a locomotive which, it is believed, had the largest driving-wheels ever used on a railroad.

This locomotive, named the *Hurricane*, was built by Hawthorne & Company, in Manchester, England, for the Great Western Railway, from designs made by Mr. T. E. Harrison, an engineer then in the service of the road. It was built in 1838, and was altered at a date not precisely known, but supposed to be about a year later, into the form shown in the drawing.

The design was a very peculiar one. The engine consisted of three separate cars or carriages coupled closely together. The first carried the cylinders and machinery, and was supported by six wheels. The center pair were the drivers, 10 ft. in diameter; the leading and trailing pair were 54 in. in diameter. The driving-axle passed above the bed or floor of the carriage, and the cylinders were coupled by connecting rods to the cranks in the axle. The two cylinders were 16 in. in diameter and 20 in. stroke, and were placed on the rear end of the carriage. It would seem that this carriage must have been loaded in some way, as the weight of the car itself and the machinery would hardly have given adhesion enough to the drivers, especially as they could not have carried much over one-third of the weight of the car. Of what load was used or how the necessary adhesion was secured we have no account.

The second carriage in the series consisted of a simple frame supported on six 54-in. wheels and carrying the boiler, which was about 48 in. in diameter. The outside fire-box was 60 in. long. The steam-pipes passed through the smoke-box and then to the cylinders on the forward car, the connection apparently being made by a sliding joint, and the exhaust pipe was returned to the smoke-box in the same way. The road was 7 ft. gauge, so that there was no difficulty in securing as wide a fire-box as might be desired. The heating surface was 624 sq. ft.

The third car was the tender. It was on four 54-in. wheels and carried the tank and coal-box.

In Wood's *Treatise on Railroads*, published in 1838, the *Hurricane*—then described as being under construction in Hawthorne & Company's shops—is referred to, and a somewhat imperfect drawing is given. From this it appears that as originally built this engine had drivers 5 ft. in diameter. The cylinders were coupled to an independent crank-shaft carrying a large pinion which geared into another on the driving-axle. The gearing was so proportioned that the driving-axle made two revolutions to one of the crank-shaft. The object was to attain a high speed without using too great a piston speed. The object of placing the cylinders and drivers on a separate carriage was to give more room and have the machinery open to inspection.

Great things were expected of this engine, which was to run express trains at the rate of 40 miles an hour. It is evident that the gearing did not work well, for in a short time it was taken out and the *Hurricane* was changed to the form shown in the drawing, with 10-ft. driving-wheels.

Of her performance in the later form we have no record, but it does not appear that any more of the same type were built; so the natural conclusion is that the results obtained

were not favorable. Insufficient adhesion, too much complication and difficulty in keeping the steam-pipes tight will all suggest themselves as reasons for dropping this type of engine, which was only one of the many experiments in locomotive design tried on the Great Western Railway under Mr. Brunel.

AERIAL NAVIGATION AT THE COLUMBIAN EXPOSITION.

THE Committee on Aerial Navigation of the World's Congress Auxiliary has issued a circular in relation to the meeting to be held as a division of the Department of Engineering during the continuance of the Exposition at Chicago. The Committee is composed of Mr. O. Chanute, Chairman; Professor A. F. Zahm, Secretary; Messrs. Elisha Gray, LL.D., H. S. Carhart, S. W. Stratton, Ira O. Baker, John Guerin, B. E. Sunny, E. L. Corthell, R. W. Hunt, D. J. Whittemore, J. W. Cloud, B. J. Arnold and W. N. Rumely. The circular is given in full below:

In connection with the various Congresses which will be held next year, under the auspices of the World's Congress Auxiliary, it is proposed to hold in Chicago, in 1893, an International Conference on Aerial Navigation, somewhat similar to that which took place in Paris during the French Exposition of 1889; the subject being one which, while it has hitherto been left chiefly in the hands of the more imaginative inventors (perhaps in consequence of the prodigious mechanical difficulties which it involves), has of later years attracted the attention of some scientific men and engineers.

Objects.—The principal objects of the conference will be to bring about the discussion of some of the scientific problems involved; to collate the results of the latest researches; to procure an interchange of ideas, and to promote concert of action among the students of this inchoate subject.

It is proposed to invite the attendance of delegates from the various aeronautical societies of the world, and generally of persons who are interested in the scientific discussion of the subject.

Time and Place.—The Auxiliary Management has assigned the afternoons of three days for this conference, being Tuesday, Wednesday and Thursday, August 1, 2 and 3, 1893. The opening session will take place at 2.30 P.M., on Tuesday, August 1, in one of the halls of the World's Congress Art Palace, now being built on the Lake Front Park, at the foot of Adams Street, in Chicago. The sessions upon the two subsequent days will also take place in the afternoon, and may either, like the first, be joint sessions, or the members in attendance may divide into two sections (A and B) as may be decided hereafter.

Topics Selected.—The topics selected for papers and discussions are as follows:

I.—SCIENTIFIC PRINCIPLES.—JOINT SESSION.

1. Resistance and supporting power of air, including results of recent experiments; formulas for the resistance of balloons or flying machines, etc.

2. Best forms of aerial propellers, including results of experiments with screws, wings, or other forms; their efficiency and the power required.

3. Motors for aeronautical purposes, whether steam, gaseous, electric, explosive, etc.; their effectiveness, safety and weight per horse power.

4. Materials for aeronautical construction, whether for balloons or flying machines; including the strength and weight of fabrics, metals, woods, etc.

5. Best structural forms for aeronautical constructions, so as to combine strength and lightness; to offer the least resistance to progression, and to alight safely.

6. Behavior of air currents, including observations at various altitudes; the prevalence, the direction, the trend and the force of winds, etc.

II.—AVIATION.—SECTION A.

1. Observations and experiments on the flight of birds, including their methods of rising, gliding, alighting, etc.; measurements of power exerted and of velocities.

2. Theories regarding the soaring and sailing of birds. It is now generally admitted that birds utilize the wind in soaring, but no satisfactory explanation of the performance has been given.

3. Various types of proposed flying machines, their advantages and defects, the power required, their safety; differences between natural and artificial wings, etc.

4. Equilibrium of flying machines, including the best means of securing safety with wings, screws, aeroplanes, etc., in rising, sailing and alighting.

5. Novel experiments in aviation and their results, either with power machines, dirigible parachutes, gliding or soaring devices, models, etc., etc.

6. Experiments with kites; results of different forms as to stability, sustaining power, height attained, behavior, etc. A history of kites.

III.—BALLOONING.—SECTION B.

1. Construction of balloons, choice of fabrics, laying out, cutting and sewing, varnishes, nets, cars, valves, anchors, guide ropes, parachutes, etc.

2. Inflation of balloons; hydrogen, coal gas, natural gas, hot air, etc.; their generation, cost, and management during inflation.

3. Navigable and war balloons, past experiments and results; the present status; the resistance, propellers, motors, speeds, etc., etc.

4. Manœuvring of balloons, ascending and descending, with least expenditure of ballast or gas; utilizing wind currents, determining altitudes, etc.

5. Observations in balloons, meteorological, photographic, topographical, military, naval, planimetric, etc., various instruments required.

6. Proposed improvements in balloons, as to forms of minimum resistance, increased strength and stiffness; with calculations of power required and lifted.

The Organizing Committee may arrange upon application for the introduction and discussion of topics not enumerated in the above list.

Proceedings.—It is intended to introduce each of these topics by the reading of one or more papers thereon, to serve as a basis for discussion, and to draw out further information. These introductory papers will be obtained both by solicitation of the Organizing Committee and by voluntary contribution. They need not be long nor very exhaustive, but decided preference will be given to those stating the results of actual experiments, as facts and positive knowledge are deemed more instructive than theories or projects. It is expected that some of these papers will be printed and distributed in advance, in which case it will be preferred to receive discussions thereon in writing.

No paper will be read unless it has previously been approved by the Committee of Organization. The management of the World's Congress Auxiliary will appoint the officers to preside over the various sessions, and these officers will arrange the order of the proceedings, call up in their turn the various papers, and the speakers whom the Organizing Committee may have selected to discuss them. Papers previously printed will generally be presented by abstract, so that discussion may follow without loss of time. Persons desiring to join in the discussions will be expected to give previous notice, and the remarks of speakers will generally be confined to fifteen minutes, and to not more than two speeches upon the same subject. It is preferred that speakers shall subsequently furnish a résumé of their remarks in writing, failing which the stenographer's notes will be edited by the committee.

Stenographers will be in attendance, and interpreters will be provided when previous notice has been given of remarks to be made in other than the English language.

It is expected that a separate room will be provided, in which to exhibit, on approval of the committee, small models or interesting experiments during the intermissions between the meetings. Should circumstances warrant, one or two additional sessions may be held.

Cards of Admission.—Personal cards of admission to the Conference will be issued in advance by the Secretary of the Organizing Committee upon application to him, approval by the committee, and the payment of a contribution of $3 to the publication fund. These cards will entitle the

holder to attend the Conference and to receive all of its subsequent publications.

Publications.—The Committee of Organization will decide how much of the papers and proceedings shall be printed, and will cause the same to be edited. Such of the papers as may be printed in advance will be mailed to the holders of cards of admission who may request it, and designate the particular topic or topics which they desire to discuss. Written discussions thereon should be forwarded to the Secretary in advance of the Conference, and after its close all such papers and discussions as may be printed shall be mailed to the members thereof.

Organization.—The President of the World's Congress Auxiliary has appointed a local committee to organize the affairs of the proposed Conference. It is to be assisted by an Advisory Council consisting of the leading scientific authorities on the subject throughout the world. Persons desiring to secure cards of admission or to contribute to the papers or discussions are requested to advise the Secretary at an early day, stating in the latter case what is the class of researches or experiments which they have made, and on what topics they desire to receive advance papers.

All communications should be addressed to Professor A. F. Zahm, Secretary, Nôtre Dame, Indiana.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 41.)

But these wonderful performances of the "sailing birds" are chiefly witnessed in tropical or semi-tropical regions—those in which the steady trade winds or the regularly incoming sea breezes afford daily to the birds the power of performing their evolutions in search of food. In the more temperate regions the wind does not blow every day with just the right intensity, the casual soaring bird is frequently compelled to resort to flapping, and the would-be inventor has his thoughts directed to some form of a power machine; generally some combination of aeroplanes with propelling screws, which differs a good deal from the simple, compact, and severe outlines indicated by nature.

The form of the soaring bird is reducible to three elements. First, a comparatively large body, shapely, but unsymmetrical fore and aft, presumably the solid of least resistance to the air; second, a symmetrical pair of wings, convex on top, and more or less concave beneath, with a sinuous and stiff front edge; and, third, a tail, which varies greatly in its proportion among the various species. For these features, most of the inventors have substituted a small, boat-like body, a combination of flat planes, and flat rudders, both horizontal and vertical, which last is not found to exist in the bird.

A good case in point is found in the instance of Mr. *Krueger*, who patented in the United States, in 1882, a flying machine consisting in three flat horizontal planes set one behind the other, the front one being triangular in plan, while the rear one might be shaped like the tail of the swallow. These were to be adjustable, so as to guide the machine up or down. Beneath them was to hang a ship or vessel, and above them were to be set still other planes, sloping like the two sides of a roof, in order to act as a parachute. Four propelling screws were to be arranged between the three sustaining planes, while four adjustable keel cloths, vertically affixed both above and below the sustaining planes, were to steady the course and to furnish the steering power.

No particular motive power was proposed, and no method indicated for maintaining the stability, so that it is quite safe to say that no experiments were ever tried with this apparatus upon any practical scale. It has been here mentioned to illustrate how misguided ingenuity sometimes runs to complications, while leaving untouched the really essential requirements.

The next inventor to be noticed, M. *Goupil*, a distinguished French engineer, began otherwise: by taking thought of the motive power and of the equilibrium. After having tried a few preliminary experiments, he designed in detail a light steam-engine and boiler, the weight of which he estimated at 638 lbs. for a machine of 15 H. P. gross, or 42.5 lbs. per H. P. He also designed a condenser of like capacity, estimated to weigh some 220 lbs. (15 lbs. per H. P.), so that the water could be used over and over again; and he then figured that the rest of the flying apparatus, without cargo, might weigh 242 lbs., thus making a total of 1,100 lbs., so that if the steam-engine worked up to two-thirds of its theoretical efficiency and developed 10 effective H. P., the total apparatus would have been in the proportion of 110 lbs. per H. P., but might be reduced to about 44 lbs. per H. P. through the use of aluminium instead of other metals.

These estimates of weights of motor and condenser have been since then more than confirmed by the achievements of M. *Maxim* and other inventors, but before seeking to realize them M. *Goupil* determined to investigate the all-important question of equilibrium.

Both observation and mathematical considerations had satisfied him that much of the longitudinal stability of the bird in the air was due to the raking shape, fore and aft, of the under part of its body, which, presenting to the air an increasing and more effective angle of resistance when

Fig. 62.—GOUPIL—1883.

pitching oscillations occur, tended to restore the balance, and to prevent the animal from taking either a "header" or a "cropper." This he determined to test experimentally, and he accordingly built, in 1883, an apparatus similar to that represented by fig. 62; omitting, however, the screw, the lower framework, and the stays to the wings.

The alar spread was 19.68 ft., from tip to tip of wings, the length was 26.24 ft. from the head tip to the end of the tail, and the mid-section was 26.20 sq. ft. in area, while the sustaining surface was no less than 290 sq. ft., the weight being 110 lbs.

It will be noticed that this was a marked departure from the ordinary aeroplane types, there being an ample body to contain machinery, and the wings being decidedly concavo-convex, while other inventors have generally endeavored to diminish the body as much as possible, and to gain support from various combinations of *plane* surfaces.

M. *Goupil's* object was to make a series of preliminary experiments with this apparatus, in order to ascertain its stability, the effect of the wind upon such a system, and the resistance to be expected, as well as the sustaining power. He accordingly applied neither motor nor screw, but exposed it to the natural wind when blowing from 18 to 20 ft. per second, say, about 13 miles per hour, at which velocity the resulting air pressure is generally assumed to be 0.85 lbs. per square foot. These experiments took place in December, 1883, at which season the winds were quite variable, and the apparatus was anchored by various ropes so as to prevent it from rising more than 2 ft. from the ground.

Exposed head on to a wind of 18 to 20 ft. per second, the body being inclined at an angle of 1 in 10 and the wings at 1 in 6 (about 10°), this apparatus lifted up clear of the ground the weight of two men besides its own, making a total of 440 lbs.! The thrust or end resistance did not

exceed 17.6 lbs. M. *Goupil* tested this several times, and expresses himself as surprised at the low resistance to penetration against the wind evidenced by this apparatus, which was mounted upon two small wheels.

When the wind increased to more than 20 ft. per second he could no longer control the machine. There being no stays or guys to the wings, such as are shown in fig. 62, the apparatus was twisted out of shape, and the wind took greater effect upon the deformed side. Then a wind gust occurred; the efforts of five men were required to control the apparatus, and one of the wings (constructed with white pine) was broken.

The inclement season and other considerations of a personal nature prevented M. *Goupil* from pursuing these experiments further at that time. He had gathered valuable preliminary data, and had caught a glimpse of a very important fact concerning the effect of concavo-convex surfaces, but his own affairs had a more immediate claim upon his personal attention.

He therefore desisted for a while and allowed the subject to remain in abeyance until he could take it up again, but he published, in 1884, a very remarkable book, "La Locomotion Aérienne," in which he advanced a number of important and new theoretical considerations concerning the solution of the problem of aerial navigation, gave data concerning the steam-engine, the condenser, and the various sizes of bird-like aeroplanes which he had designed, and generally evinced such a grasp and comprehension of the question that it seems a marvel that the book is not more frequently referred to by the French writers on aviation.

This experiment of M. *Goupil* opens up quite a new field of inquiry concerning the effects of concave, bird-like surfaces, when exposed to an air current. Calculated by the data which have been gathered by experiments upon plane surfaces, the "drift" and total resistance does not seem to vary greatly from what might be expected, but there is an enormous, an almost incredible increase of the lifting power.

Thus there was said to be a total end thrust of 17.6 lbs. in the apparatus when exposed to a wind of about 13 miles per hour, at which the air pressure would be presumably some 0.85 lbs. per square foot. The angle of incidence of the wings was practically 10°, and we may, without serious error, assume the resistance of the body to have been one-tenth of that due to its mid-section, while that of the edges of the wings (presumably 0.20 ft. in average thickness) would be about one-third of their plane cross-section. As the sustaining surface was 290 sq. ft., we then have, using the table of "lift" and "drift" heretofore given, the following estimate:

RESISTANCE OF THE GOUPIL AEROPLANE.

Drift 10°.....	$290 \times 0.85 \times 0.0585$	= 14.42 lbs.
Body.....	$26.9 \times 0.85 \div 10$	= 2.28 "
Edge of wings..	$19.7 \times 0.2 \times 0.85 \div 3$	= 1.11 "
	Total	17.81 "

which agrees closely with the amount said to have been ascertained by experiment; but when we come to calculate the lifting force we have:

$$\text{Lift } 10° = 290 \times 0.85 \times 0.332 = 82 \text{ lbs.},$$

while the apparatus is said to have actually lifted 440 lbs., or more than five times as much!

Of course various allowances must be made in considering the results of an experiment carried on in a variable wind, and where so little motion of the apparatus (2 ft.) could be allowed. The thrust may have been measured while the breeze was steady, and the uplift to have occurred during a wind gust, deflected possibly by surrounding objects so as to produce a greater angle than 10° with the wings; still, in any case, the result of this experiment and also of other experiments by M. *Phillips*, which are to be described hereafter, leads to the inference that much greater supporting power is to be obtained from concavo-convex surfaces than from the flat planes which hitherto have been chiefly proposed for aeroplanes.

This increase in supporting power might indeed have been expected from the theoretical consideration: that the concave lower surface would produce a higher co-efficient of pressure, while the convex upper surface would deflect the current of air impinging at an acute angle thereon, and thus produce a partial rarefaction; and also from the much stronger practical consideration that *this is the way the wings of birds are shaped;* and yet very few experiments and proposals seem to have been made with bird-like aeroplanes.

This neglect may possibly be due to the fact that the proportions, the shape, the concavity and the convexity of natural wings differ from each other among the various species, so that the moment that we discard the flat plane, a multitude of combinations present themselves, which may require long and careful experimenting before the best shape for an artificial machine is ascertained.

It is understood, however, that M. *Goupil* has planned a whole systematic series of such experiments to elucidate this important matter, and that he hopes soon to be in position to carry them on.

In March, 1884, the *Aéronaute* published a paper by M. *De Sanderval*, giving an account of some very interesting experiments, which he had tried with a pair of artificial wings no less than 39 ft. across and 13 ft. wide in the middle. These wings formed an aeroplane, or *rigid* plane of canvas, stretched upon wooden arms, which latter, however, possessed a certain flexibility.

In a first set of experiments, this aeroplane, loaded with ballast to the amount of 176 lbs., was allowed to glide in calm air along a cable 1,300 ft. long, which both supported and guided it, and which was inclined at a slight angle. It was also allowed to drop in still air from a height of 131 ft., and then still further experiments were tried with men riding on the machine when the wind was blowing.

For this purpose the aeroplane and its operator were suspended by a long rope from the middle of a cable, stretched in some cases between two hills and over a ravine, and in other cases between two high masts erected near the seashore.

M. *De Sanderval* states that he was attached some 5 ft. above the aeroplane and a little in front of its center of figure, so that by pulling upon four oblique cords he was enabled to shift his weight either forward or back, and to the right or left at pleasure.

When the wind blew and the apparatus was restrained by a head-rope, the effect was much the same as when gliding free in calm air, with, however, the unfavorable difference that when near the ground it was less steady by reason of whirling currents.

In a light wind the apparatus would rise until the suspending rope became horizontal, thus relieving it of its weight-carrying function, and the aeroplane would then oscillate at the pleasure of the operator.

When the wind increased to 18 miles per hour the apparatus would sustain the operator and two assistants.

Subsequently, M. *De Sanderval* gave an account of his experiments to the French Academy of Sciences, and this was reprinted in the *Aéronaute* for November, 1886, with the somewhat uncalled-for comment that "it is a pity that the author should not have stated the time, the place, nor the witnesses, as such extraordinary facts need verifying."

The following are the facts as stated:

My first apparatus consisted in two wings, each 19.68 ft. long, thus giving an aggregate spread of 39.36 ft., by a maximum width of 13 ft. These wings were of canvas, stretched upon bamboos and upon wooden arms. The canvas was divided into a series of parallel sheets or flaps, each 4¾ in. wide, and perpendicular to the dorsal line. They were suitably fastened, and a net was stretched above them, so that they might flap and open upon the upstroke, like the feathers of birds, which oscillate upon the quill which divides them into two unequal portions.

Standing upright upon a light board, and connected by straps to a central spine, I was enabled by thrusts of the legs to develop their maximum effort; but with this apparatus, which worked quite well, I was enabled to settle but one fact, and that is, that man cannot develop sufficient energy to sustain himself in calm air. I therefore gave up the thought of beating wings.

I then rebuilt the apparatus, transforming the wings into a rigid plane, and replacing the flapping strips by an unbroken canvas.

This apparatus, weighing 99 lbs., and loaded with 176 lbs. of ballast, was caused to glide under a cable 1,300 ft. long, stretched between two bluffs. There was no deflection in the

cable when the aeroplane glided across at speed, but the deflection was about 26 ft. when the apparatus was stopped in the middle.

If then released (by tripping a hook) it would at first drop almost vertically; then after the first second it would glide forward at increasing speed, while the rate of vertical fall diminished; but upon the slightest disturbance in the equilibrium, consequent upon any divergence between the center of gravity and the center of pressure, the inert ballast would aggravate the oscillation, and the apparatus would plunge down to smash. It seemed evident to me that if intelligence were applied to regulate the position of the center of gravity, steady progression would result.

I then suspended the apparatus by a long rope attached in the middle of the cable, and substituted my own person for the ballast. I found that with an intelligent live control the apparatus would oscillate in the wind according to my pleasure, as I have already indicated in a previous communication. The supporting surface of 301 sq. ft. sufficed to sustain a man at a comparatively slow rate of fall, and by a wind of 22 miles per hour it lifted me up with two assistants, and sustained us in the air during the entire period that we kept the holding-back line taut, by maintaining a proper angle of incidence.

The last and more interesting experiment which I attempted was based upon these previous results, and also upon the fact that soaring birds can rise into the air on a helical path, or else maintain themselves a long while at the same altitude without beating their wings, provided always that they possess sufficient horizontal speed as regards the air. I therefore experimented with an apparatus somewhat similar to the preceding, but round in shape, suspended by a vertical rope 650 ft. long,* and caused it to swing around in a circle, so that the suspending rope described in its path the outer periphery of a cone. In this experiment I could feel a notable reaction against my weight, but it required a much longer suspending rope to allow so large an apparatus to swing in a circle of sufficient diameter to permit its gaining the necessary speed, and to manœuvre freely. I believe, however, from the feeling that I had really taken possession of space within the limits of my somewhat irregular speed, produced upon my mind by the experiment, and also, from my observations of soaring birds advancing against the wind on rigid wings, that man can succeed in reproducing sailing flight.

If one had an unlimited height to fall in, affording plenty of time to think and to act, he would probably succeed in guiding himself at will. In calm air man does not possess sufficient energy to sustain himself, but either in a sufficient wind, or with a proper horizontal speed of his own, he finds himself under different circumstances, and derives from the air quite enough supporting power. It is through the operation of this dynamic equilibrium that he will eventually succeed in compassing practical flight.

I caused to be constructed, from manuscript notes furnished by M. *Biot*, a very ingenious apparatus intended to comply with the above conditions, and I experimented with it. This apparatus consisted in two great wings supported on a light carriage, which gained its initial speed by rolling down a long incline covered with an asphalt floor. It rose into the air pretty well, but always with the disadvantage that the experiment could not be sufficiently prolonged to furnish decisive results; each time upon coming down the apparatus was injured.

It appears to me that a long, vertical rope, such as that previously described, swinging around so as to describe a cone of extended base, must afford greater chances for careful experiment and for eventual success.

The writer has been unable to find any further records of experiments by M. *De Sanderval*. He seems to have been baffled by the lack of means to maintain equilibrium, but even had he possessed the appliances and the skill to bring the center of gravity to coincide with the center of pressure, as often and as fast as the angle of incidence changed, it may be questioned whether he could have acquired, without a very long apprenticeship, that instinctive use of them which constitutes the science of the birds.

It is inferred from the description that M. *De Sanderval* experimented with plane surfaces, although it is possible that under the action of the wind they may have assumed those concavo-convex shapes which we have seen to obtain with the birds and to be more effective than flat planes. In any case, he is to be commended for having made an earnest if unsuccessful effort *to learn how to soar in a wind like a bird*, the possibility of which performance for man will be further discussed hereafter.

In 1884 M. *Armour*, the author of several papers which will be found in the reports of the Aeronautical Society of Great Britain, patented a flying machine, in which he proposed the use of aeroplanes or wings, oscillating upon springs transversely to the line of motion, these wings being set behind each other as well as superposed. It is not known whether any experiments were tried with this curious device, which seems to be a combination of fixed wings (or aeroplanes) with oscillating wings, but it seems doubtful that it can prove efficient.

There was a second aeronautical exhibition in 1885, under the patronage of the Aeronautical Society of Great Britain, but the total number of exhibits was only 16 as against 78 in 1868.

Among these exhibits the model which attracted most attention was that of M. C. *Ring*, of Denmark, which consisted of an aeroplane with a pair of arched wings, somewhat similar in the front-edge view to the arched wings of the gull and of the albatross. In plan, however, these wings were rectangular instead of the approximately triangular shape which obtains with the birds. These aeroplanes were to act as sustaining surfaces, the angle at which they met the wind being determined by the position of a large flat tail, and the propulsion being furnished by four wing-propellers oscillating beneath the aeroplane, and driven in the model by twisted rubber.

The apparatus was supported by a string fastened vertically above its center of gravity to the crosspiece of a light framework. It propelled itself slowly, but was incapable of free flight, probably in consequence of defective equilibrium.

M. *Ring* also exhibited a model of a gun-cotton engine in which small charges were to be exploded between two pistons, moving in opposite directions in a long cylinder; but the model was not a working one, and no attempt was made to construct a full-sized engine.

Reference has already been made to a "trunk steam-engine," shown by M. *S. Hollands* at this exhibition. He gave a description of this and of two other types of light steam-engines with which he had experimented, at subsequent meetings of the Aeronautical Society of Great Britain.

The first was a "direct-acting" engine, rotating at high speed *twin* vertical screw fans (right and left) in opposite directions, and a model of this machine, developing $\frac{1}{12}$ H. P., was said to have weighed 6 oz. for the engine and boiler, or at the rate of only 6 lbs. per horse-power. It was first intended to generate the steam by burning liquid fuel, but M. *Hollands* subsequently concluded that hydrogen gas, carried highly compressed in a suitable reservoir, and burned with an admixture of twice its volume of air, would prove preferable for lightness and heating efficiency. He estimated that the weight of this type of motor, including not only the engine and boiler, but also the water therein, the fuel-gas reservoir and the driver's stand, would be 11.5 lbs. per indicated horse-power.

The other engine was "geared" so as to rotate two right and left fans on *concentric* vertical shafts, one inside of the other, through the intervention of toothed mitre gear. The function of these two vertically superposed fans was to lift only; a smaller horizontal fan being carried on a prolongation of the crank-shaft, and its thrust aided by the reaction of the exhaust steam ejected through a suitable nozzle. The weight of this engine per horse-power is not stated.

Both these arrangements, it will be observed, involved discharging the exhaust steam into the air, and thus wasting some 20 to 22 lbs. of water per horse-power per hour, M. *Hollands* not seeing his way to adding an aerial condenser (to recover the steam) in any form, within any admissible limits of weight. He stated that the power necessary was one indicated horse-power for every 30 lbs. of the whole weight, so that without a condenser the flight of such an apparatus as he proposed would have been limited by the very small quantity of water which it could lift.

M. *Hollands*, however, made some experiments on the best form of lifting screw-blades, and stated that he had found it advantageous to make the fan blade concave on the driving or lifting side, and that the angle of maximum efficiency

* Stated at 200 meters: may be a misprint.]

was 15° with the plane of motion at the tip, and 30° at the root. The form which he found most efficient was two-bladed; with the blades narrowest at the tips, slightly concave on the lifting side, the tip slightly drooping, each blade being approximately the shape of an elongated shallow spoon or scoop, and with a pitch equal to about two-thirds of the fan's diameter, giving a mean angle of blade of 22° 30′ with the plane of motion. These blades were of thin sheet steel, and their forms will be noted as confirming what has already been stated as to the advantages of the bird-like form of wing. M. *Hollands* said further:

I find another advantage accrues also from the use of these very thin, sharp edged hollow blades—viz., that there is *no appreciable resistance to rotation that does not contribute to lifting effect.* A marked contrast to this desirable quality is presented in the results given by *flexible bladed* fans, constructed to *vary their pitch* automatically, being normally of *coarse* pitch (when still), but decreasing their pitch when rotated, and further decreasing it with increase of speed. Some experiments I made with fans of this description showed an unmistakable loss of power, as compared with the other type above described, due apparently to the energy absorbed in deflecting the elastic blades; which deflection, with a given speed, causes a constant strain and resistance, with no compensating useful effect.

In 1888 *W. Beeson* patented, in the United States, the singular soaring device shown in fig. 63. He had already patented, in 1881, a soaring apparatus consisting of two or

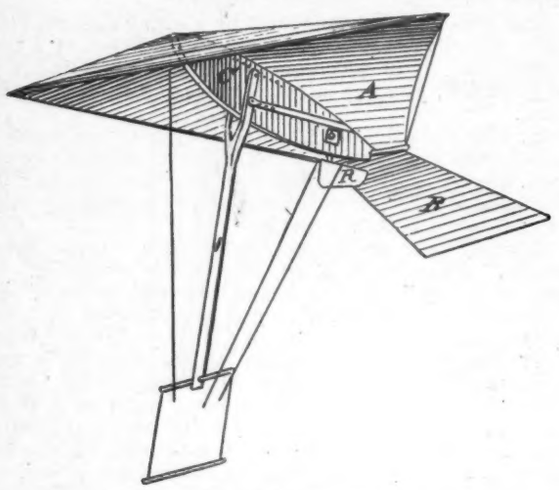


FIG. 63.—BEESON—1888.

more sets of adjustable superposed sails stretched on inverted A frames, which he expected to raise into the air like a kite, and then sail upon the wind, but he apparently abandoned this device in favor of the simpler form shown in fig. 63.

This consisted in a mainsail *A* and a tail or back-sail *B*, both of which were supported on a plate or board *C*, ranging fore and aft. This plate was convexed at its upper edge so that the sail *A* might extend over, forward and downward to a cross-bar forming the front edge, and thus enclose a head pocket to catch the wind. A forked pendulum-bar, *I*, was pivoted to the plate *C*, and it supported at its lower end a trapeze arrangement to carry the operator, who by means of three light cords extending to his hand might alter the angle of incidence of the mainsail *A*, of the tail *B*, or of the rudder *R*. The mainsail and tail being, moreover, connected by an adjustable bar, which caused the mainsail to act upon the tail automatically, so as to maintain the equilibrium at all angles of incidence through the compound lever thus formed.

M. *Beeson* states in his patent that "this machine is self-supporting in a light wind, say, of 10 miles or more per hour, and that when once raised by a kite or otherwise, and cut loose, it will of itself perform the evolutions of a soaring bird and rise to any altitude."

The writer confesses that he has tried the experiment with a small model and has failed; and so, in the hope that some of his readers may be more fortunate, he has given this account of what seems to be a remarkably simple device—if it will work.

(TO BE CONTINUED.)

COLUMBIAN EXPOSITION NOTES.

THE most approved methods of artificial ice making and cold storage will be exhibited at the World's Fair. These processes will be shown in a very fine building, 130 × 255 ft., and five stories high, with observatories at the corners and a lofty tower at the center. About 80 tons of ice will be manufactured daily, three methods being employed—namely, the plate system, from filtered water; the can system, from condensed steam filtered and purified; and the can system from de-aerated water. Three different processes of cooling rooms will also be shown.

OHIO will erect a mineral cabin in the Mines Building at the World's Fair to illustrate its mineral resources. The cabin will be 32 × 61 ft. in dimensions and 23 ft. high, and be constructed entirely of Ohio mineral products.

THE Machinery Department of the World's Fair, at Chicago, will be an interesting one to mechanics. The Egan Company, of Cincinnati, the famous builders of wood-working machinery, will make the finest display ever made in that line. Some novel time and labor-saving machines will be shown in practical operation.

AMONG the questions suggested for discussion at the Electrical Congress in Chicago next summer are the following of general interest:

Comparison between procedure in different countries.

Methods of avoiding electrical interference, and risks to persons and property.

Units of magnetic quantities, and mode of embodying them in concrete standards.

International nomenclature for describing phenomena of alternate currents and of electro-magnetic waves.

National and municipal testing laboratories.

Materials for standards of electric resistance.

Points of difference of the electrical vocabulary used in different countries.

The direct conversion of the energy of fuel into electric energy.

Comparison of the various methods employed for the electric transmission of power.

The cost of insulation in relation to high pressure for the electric transmission of power.

Comparison of the economics of the various systems of electric distribution.

Electric traction.

Application of electric power in mining.

Commercial instruments for measurement of electric quantities.

The electric working of metals.

The use of electric and magnetic tests for ascertaining the mechanical properties of metals and alloys.

The best material and mode of erection of lightning conductors in the light of recent researches in electric discharges.

The prospecting for iron by magnetic surveys.

International telegraphy.

Fast-speed and long-distance telegraphy.

Telegraphic lines, land and sea.

Harmonic telegraphy.

Writing telegraphs.

Long-distance telephony.

The possibility of providing telephonic communication without wires.

Application of electric signaling to the working of railroads (alarms, time, etc.), and to naval and military purposes.

Magnetic separators.

The use of electricity in engraving and in art reproductions.

Besides these, a large number of questions are suggested which are purely technical, and therefore of interest only to electricians.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées.*)

(*Continued from page* 23.)

It has already been stated that there are in India two classes of canals: Inundation canals, which are only fed during the floods; and irrigation canals, which are supplied with water at all seasons. The canals of the latter class are the most important and interesting, and it is of these only that mention is made here.

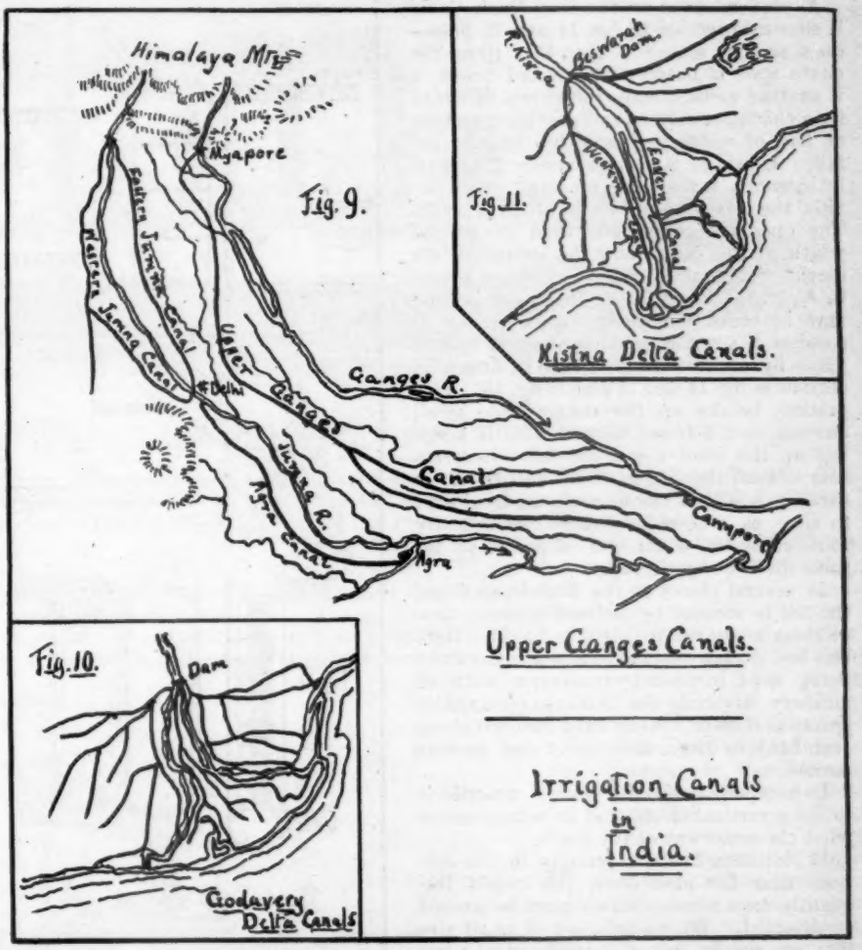
It is not easy to point out any established rules for the section or profile of these canals, which naturally vary according to local conditions. Generally the section of the principal canals seems to be so arranged that the depth of water shall be from 6 ft. to 10 ft. The fall is variable; but it seems to be assumed that the minimum rate of flow to prevent deposits and the growth of aquatic plants should be about 1½ ft. per second.

There is, however, one very essential precaution. The rivers of India are generally heavily charged in time of flood with matter in suspension, and, to avoid heavy expense in cleaning out the canals, it is necessary that this matter be carried as far as possible to the land irrigated, and not deposited in the canals. All retarding causes in the main canals must therefore be avoided, and the fall in the secondary or distributing canals should be somewhat greater than in the main canal. The work of cleaning out the small distributing canals is easier and less costly than that for the main canals.

The section of course varies with local conditions and local needs.

Many of the main irrigation canals are also used for navigation. In this case the fall must be regulated so that the current will not interfere with the passage of boats, and all dams must be provided with locks.

Some examples of the greater canals are given in the accompanying sketch maps. Fig. 9 shows the Upper Ganges Canal, the Eastern and Western Jumna canals and the Agra Canal.



The Upper Ganges Canal, which extends from the Myapore Dam to Cawnpore, is 181 miles long; its chief branches are 410 miles in length, and they supply a system of distributing canals having a total length of about 3,400 miles and supplying water to 950,000 acres of land. The main canal is 160 ft. wide at its head, and receives from the river an average of 6,000 cub. ft. of water per second in summer and 3,600 cub. ft. in winter. The depth of water is 10 ft. with the maximum delivery.

The Eastern Jumna Canal receives usually about 1,250 cub. ft. of water per second from the Jumna; the main canal is 130 miles long, supplying about 625 miles of distributing canals, which irrigate 210,000 acres. The Western Jumna Canal is 102 miles long, has 313 miles of large branches and supplies 515,000 acres. It takes from the Jumna an average of 2,500 cub. ft. per second.

The Agra Canal, which also receives water from the Jumna River, extends from a point near Delhi to Agra, 140 miles; its distributing system includes about 310 miles of branches. At the head this canal is 70 ft. wide and 9 ft. deep; it receives an average of 1,975 cub. ft. per second.

The Lower Ganges Canal is 213 ft. wide and 10 ft. deep at the head. It is 313 miles long, has 846 miles of large branches, and supplies water to 525,000 acres of land. Of this system 634 miles are navigable.

In the Punjab the Bari-Doab Canal, which takes water from the Ravi River, the chief tributary of the Upper Indus, is 140 miles long; it supplies water to 220 miles of large branches and 830 miles of distributors, irrigating 550,000 acres. Of this system 190 miles are navigable.

A peculiar system is that of the Godavery Delta, shown in fig. 10. It includes three main canals, numerous branches and a system of distributing canals which supply 900,000 acres. The Kistna Delta has a somewhat similar system, shown in fig. 11. Two main canals start from the Beswarah Dam, and through a network of branches and distributors irrigate nearly 1,400,000 acres.

Other works of this class which deserve mention are the Orissa canals in the Mahanuddy Delta, and the great Sirhind Canal in the Punjab, recently completed.

The head-works of the canals as a rule consist of piers of masonry supporting sliding gates, which serve to regulate the delivery of water. They have masonry foundations, protected above and below by rip-rap. On the Upper Ganges Canal the piers are 20 ft. apart, but the gates are too large to be easily handled, and in most cases the openings are not over 8 or 10 ft. Similar works are frequently placed at other points, where it is desirable to regulate the flow of the water, or to divert it to branch canals.

In deltas or the lower parts of river valleys, where the natural fall is slight, the distributing works are usually found sufficient to regulate the flow of water and keep it below the point where corrosion of the banks is likely to occur. Where the natural slopes are greater the excessive fall is overcome by inclined planes or chute walls at intervals across the canal.

A work of this class on the Upper Ganges Canal is shown in section in fig. 12 and in plan—on a smaller scale—in fig.

13. The fall here is 8 ft., and the bed of the canal is of masonry for about 120 ft., the foundations consisting of rows of wells sunk in the clay soil. At the upper end, just above the chute, is a bridge of eight arches of 24 ft. span, the piers having a thickness of 4½ ft. To regulate the flow and keep it parallel with the channel, three of the piers are continued 85 ft. below the bridge. The bank walls or abutments are carried still further, and are curved inward at the ends, as shown in fig. 13, in order to throw the current toward the center of the canal and prevent corrosion of the banks.

These works have the drawback of increasing the velocity of the current and lowering the water level above them too much, and to prevent these results various plans have been tried, with more or less success.

A plan adopted on the Bari-Doab Canal is shown in section in fig. 14 and in plan—on a smaller scale—in fig. 15. Here the chute wall is nearly vertical, and below it is another vertical wall, the object of which is to check the current and provide a cushion or bed of water to lessen the force of the fall. A bridge is carried across the canal by masonry arches, the piers of which divide the flow into openings of 10 ft. each. The openings are greater than the normal width of the canal, and the abutments are carried below and turned inward as shown in fig. 15. A special arrangement is used here to break the force of the current. It consists of a sort of grating of wood held in place by an iron frame; this is shown in section in fig. 14 and in plan in fig. 15. This grating breaks up the current into small streams, and is found to serve well in keeping up the level above the fall; it serves also to hold the larger débris carried down the canal, which can be removed from time to time as required. Below the masonry foundation the canal bed is protected for some distance by rip-rap.

In several places on the Bari-Doab Canal the fall is secured by inclined planes. One of these is shown in plan in fig. 16. Here the bed of the canal is of rip-rap, the stone being kept in place by transverse walls of masonry, dividing the bed into rectangular spaces as shown. Wing walls are built along each bank to direct the current and prevent corrosion.

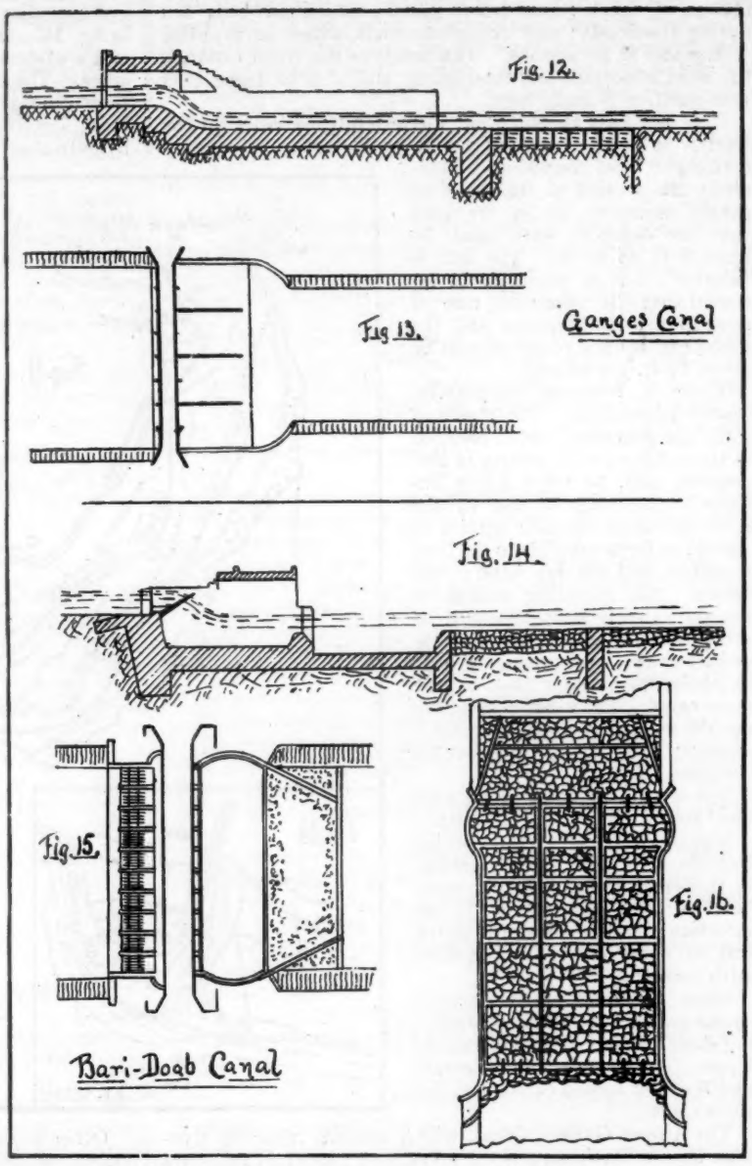
In Southern India the general practice is to use a vertical chute, and to reduce somewhat the waterway at the chute.

In Northern India, especially in the sections near the mountains, the canals frequently meet streams which must be crossed or diverted. Where these are of small size they are simply turned into the canal; but in many cases they must be carried over it by an aqueduct, or under it by a siphon. Some of these works are of considerable size and importance. Where the Ranipore crosses the Upper Ganges Canal there is a receiving basin covering 30 acres, from which a passage consisting of several parallel arched culverts of masonry leads under the canal. On the Agra Canal the overflow from the Mandampoor Reservoir is carried over the canal by an iron aqueduct supported by girders resting on stone piers.

There are a few places where such arrangements are not possible. At Dhanauri, on the Upper Ganges Canal, such an instance is found, where the Ratmu Torrent crosses the canal at a level. Here the stream is led into a receiving basin covering about 83 acres, from which the water passes into the canal by a series of gates which can be closed when required. On the opposite side the water passes out of the canal by a series of openings of various depths, which can also be closed by gates working between masonry piers. Below the crossing is a regulating dam. This crossing is only used at high water; in the dry season, when the flow of the Ratmu is small, the surplus water is carried under the canal by two masonry culverts forming a siphon.

There are several cases where canals can be carried above the streams by aqueducts. One of this kind is found where the Upper Ganges Canal crosses the Solani River at a height of 35 ft. above the river-bed.

This aqueduct is a masonry bridge 920 ft. long, having 15 arches of 50 ft. span; the piers are founded on wells sunk in the river-bed. The aqueduct is divided by a longitudinal wall into two channels; it usually carries a depth of 10 ft. of water.



Another interesting aqueduct is carried across a branch of the Godavery on 39 arches of 40 ft. span. The channel of this aqueduct is 23 ft. wide and it usually carries a depth of 6 ft. of water. Its bed is of concrete covered by a layer of clay.

Of course there are many other works along the line of the canals, such as bridges, locks for the passage of boats where the canals are navigable, and others of various classes; but no description of these is necessary, as they have no special relation to irrigation.

It may be noted that the fall produced by regulating or other works is often used to run the native grist-mills.

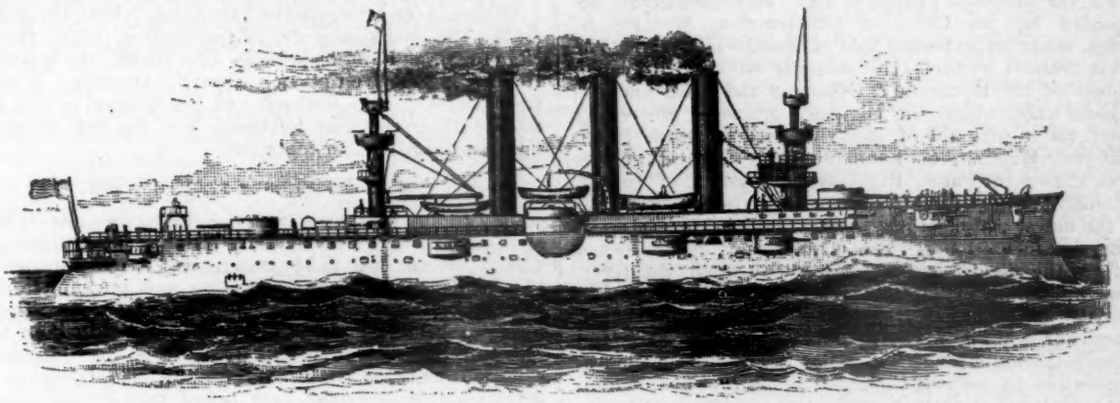
Many drainage works have been executed to carry off surface water and the surplus water of irrigation, and to improve lands adjoining the canals. These works are of various kinds and classes.

It may be mentioned that one difficulty is found in the neighborhood of many of the canals. In consequence of the evaporation at the surface of the soil of the water of infiltration from the canal, there are left saline efflorescences which are difficult to remove, and which make the land sterile.

HOME NAVAL NOTES.

THE contracts for the new armored cruiser *Brooklyn* and the battle-ship *Iowa* have been let to the William Cramp & Sons Company in Philadelphia, whose bids on both ships were the lowest.

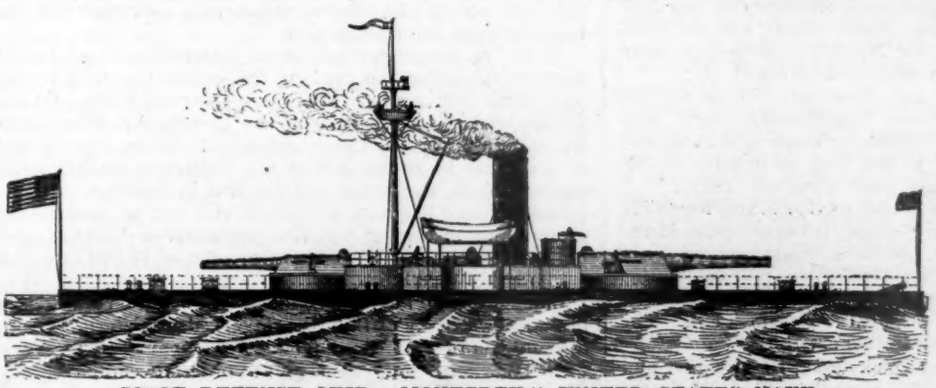
The general appearance which the *Brooklyn* will present is shown in the accompanying sketch, from the *Iron Age*.



DESIGN FOR NEW ARMORED CRUISER "BROOKLYN," FOR UNITED STATES NAVY.

The great height of the smoke-stacks is perhaps the most marked feature.

The *Brooklyn* is of the same general type as the *New York*, but somewhat larger. Her dimensions are: Length on load-line, 400.50 ft.; extreme beam, 64.83 ft.; mean draft, 24 ft.; displacement, 9,150 tons. She will have four triple-expansion engines, intended to work up to 16,000 H.P. and give a speed of 20 knots an hour. The normal coal capacity will be 950 tons, and 1,650 tons can be stowed when needed.



COAST DEFENSE SHIP "MONTEREY," UNITED STATES NAVY.

The armor will include a 3-in. water-line belt, a heavy protective deck, 8-in. barbettes and 5½-in. turrets for the guns of the main battery, besides heavy shields for the other guns.

The battery will consist of eight 8-in. breech-loading rifles; twelve 5-in. rapid-fire guns; twelve 6-pdr. and four 1-pdr. rapid-fire guns; four machine guns and two field or boat guns. The 8-in. guns will be mounted in the turrets on the barbette and will have a wide arc of fire. There will be five torpedo-tubes, one in the bow and two on each side.

The ship will have a radius of action at full speed of 1,792 knots, and a cruising radius at 10 knots of 6,216 knots.

The hull and fittings were designed by the Bureau of Construction and Repair, under the direction of Chief Constructor T. D. Wilson, U.S.N., and the machinery by the Bureau of Steam Engineering, under the direction of Engineer-in-Chief George W. Melville.

TRIAL OF THE "MONTEREY."

The official trial of the new coast-defense ship *Monterey* took place January 5 in the Bay of San Francisco. The official report has not yet been made public, but it is understood that on a four hours' run the main engines averaged 162 revolutions and developed 5,450 H.P. The auxiliary engines will add about 150 H.P. to the total. The average speed was about 14½ knots and the maximum 15 knots. The engines worked well both on the natural and forced draft trials.

The accompanying cut of the *Monterey* shows the vessel as originally designed by the Bureau of Construction. The only material change since made is the substitution of 12-in. guns for the 16-in. guns originally proposed.

The special feature of the *Monterey* is the use of the Ward tubulous boilers. These worked very well on the trial, furnishing all the steam needed.

IT is said that the question of building the torpedo-cruiser authorized some time ago in one of the navy-yards has been considered; but it is probable that nothing will be done unless Congress should authorize an increase in the amount appropriated for her construction.

DESIGNS are in preparation for the four torpedo-boats or launches which are to be carried by the *Maine* and the *Texas*. These boats will be about 60 ft. long, 9 ft. beam and 15 tons displacement. They will have Ward tubulous boilers and quadruple-expansion engines of 200 H.P.; their calculated speed will be 18 knots.

THE largest contracts for armor-plate ever let in this country will shortly be given out. A little over 7,000 tons of plates of various sizes and thickness will be needed for the ships now authorized. It is thought that the contracts will be divided among several firms.

AN appropriation of about $2,500,000 will be asked for this year to continue the work already begun on coast defense works at New York, Hampton Roads and San Francisco. The plans for these works are now completed, and a beginning has been made, but new appropriations are needed to carry on the work.

THE BALTIMORE & OHIO RAILROAD'S EXHIBIT AT THE WORLD'S FAIR.

DURING a recent visit to Baltimore, we had the pleasure of inspecting the exhibit which the Baltimore & Ohio Railroad Company is preparing for the Columbian Exhibition under the supervision of Mayor J. G. Pangborn. The exhibit is to be designated "The World's Railway; Its Conception, Inception and Perfection; Its Motive Power, Equipment and Appliances."

The following excellent description of this exhibit is condensed from one which the New York *World*, with commendable enterprise, published in its issue of January 8.

With the proposed exhibit in view, Major Pangborn, accompanied by his Chief of Construction, William G. O'Brien, made an extended tour of Europe last year. The interest aroused by them, the personal attention drawn to the plans of the Baltimore & Ohio and the broad and liberal basis upon which the company proposed proceeding secured the hearty aid of such institutions as the South Kensington Museum, of London; the Conservatoire des Arts et Metiers, of Paris; the National Museum, of Vienna, and the Edinburgh Museum, of Scotland. In these are treasured the oldest and most important examples of steam locomotion now in existence. From these drawings full-sized models of the engines have been made in wood, the different working parts being arranged to move, as they did in the actual engine, when the model is rolled on the track prepared for it. The wood is painted to imitate metal, and so close is the imitation that at a few feet from the model it is impossible to tell whether it is made of wood or iron. These models are as exact reproductions as it is possible to make of those historical engines from the most careful measurements of originals, the institutions named having the working drawings especially prepared and forwarded for the purpose. The models have been made in a building at the west end of Baltimore Street, which is occupied as a workshop, and is filled with a corps of pattern makers and draftsmen.

PRIMITIVE LOCOMOTIVES.

The Messrs. Stephenson were induced for the first time to permit tracings to be made directly from the original drawings by George Stephenson of some fourteen of his earliest locomotives. Three of Stephenson's locomotives—his first, the *Blucher* (1816), his famous *Rocket* (1829), and the highest type of his *Planet* class, the *Mercury* (1830)—have been duplicated full size from his original drawings.

From the measurements and drawings sent on by the Conservatoire of Paris full-size reproductions have been made of the oldest example of steam locomotion in existence, that of Cugnot (1769), and of the first locomotive in the world with multitubular boiler, that of Seguin (1827).

Likewise, from measurements of originals and following the working drawings prepared under the supervision of the South Kensington Museum, full-size reproductions have been made of the *Puffing Billy* (1813), the first locomotive with smooth wheels for smooth rails, and the *Sans Pareil* (1829), the first introduction of the steam blast. The *Puffing Billy* is the oldest locomotive existing.

Two grandsons of Timothy Hackworth, the designer and builder of the *Sans Pareil*, who recently visited Baltimore to inspect the reproduction, say it is difficult to tell the duplicate from the original.

EVOLUTION OF STEAM PROPULSION ON LAND.

The few of the full-size working reproductions enumerated embrace but a small section of the whole. The exhibit begins with the first method of propulsion by steam on land—that of Sir Isaac Newton in 1680; thence the evolution is indicated through the Cugnot (1769), the Murdoch (1784), the Read (1792). The latter, by the way, was the first steam wagon in America, and its designer; Nathan Read, of Salem, Mass., was the inventor of the multitubular boiler, without which the locomotive of the present day would be an impossibility. Following the Read comes the first Trevithick, the initial design (1800) of the father of the locomotive, Richard Trevithick, a Cornish colliery foreman. In 1803 he built the first locomotive that ran upon a rail. Attached to the full-size reproduction of this first of all locomotives will be the two original little flat cars it drew upon the South Wales colliery road.

A remarkable copy is that of an invention by Oliver Evans, who in 1804 accomplished in Philadelphia propulsion on land by steam. It was a queer-looking thing for surface travel, and never intended for such, being in reality a dredger. But Evans propelled it by gearing from his engine to temporary wheels, and although it weighed upward of 40,000 lbs., propelled it successfully through the city streets to the Schuylkill River.

Up to this time no steam carriage or wagon on common roads, or the Trevithick locomotive on rail, had done much more than move with its weight, which in no instance exceeded a third of that of the Evans make.

Others in the series are the Trevithick (1808), the Brunton (1811), the Blenkinsop (1812), the Hedley (1813), the *Novelty* (1829), and the *Stourbridge Lion* (1829), the last named the first locomotive to turn a wheel in America. It did little more than turn a wheel, and the Cooper, on the Baltimore & Ohio the year following, was the first locomotive built on the American continent.

WEEDING ERRORS FROM HISTORY.

Major Pangborn, his Chief of Construction, Mr. O'Brien, and his Chief Draftsman, Mr. Wright, encountered great difficulties not only in the meagerness in many instances of obtainable facts, but in conflicting and incomplete drawings. Books follow books, one copying from another repeats inaccuracies, and an illustration, made probably largely from imagination originally, gets to be regarded as standard when, if those who used it had taken time to investigate, they would have found that by no principle known in mechanics could such construction as is delineated be made to work.

Months have been spent in going through old records, hunting up old data and tracing information of importance. Abroad most of the links in the chain of historical development have been preserved.

In this country the people who have made history have frequently been too busy creating it to note its recording. Fortunately, the World's Exposition coming when the pioneers of the American railroad have not all been forgotten, there is an earnest endeavor to establish history, and the part the Baltimore & Ohio is taking in this important field will possibly be even more generally appreciated in the future than at the present time.

In no line of research has keener interest been maintained than in following the trial of the locomotives which took part in the Baltimore & Ohio competition of 1831. Of the similar trial of locomotives on the Liverpool & Manchester Railway in England, a year and a half before, every detail is preserved in books, but of the Baltimore & Ohio trial, the second in the world and the first in America, no connected account has been published, and not an illustration or drawing of any of the five locomotives designed and built in response to the company's offer of $4,000 in prizes is known to be in existence.

In uncovering facts in connection with the contest, the files of newspapers of that day preserved in historical societies and libraries of Maryland, Pennsylvania and New York were laboriously gone over, and in order to embrace every possible source of information, advertisements were inserted in Pennsylvania and New York papers seeking communication with the descendants of those who designed and constructed the engines. Old employés of the company have been interviewed, and in every way were the inquiries pushed, until finally the long and painstaking delving was rewarded with such results as to enable the building in perfect fac-simile of all five locomotives. No single event in the railroad history of America could have been of higher historical value to establish than this.

IMPORTED LOCOMOTIVES.

The Baltimore & Ohio was the only pioneer railroad of this country not taking foreign models for locomotive construction or importing foreign locomotives for service. It has been generally supposed that the half dozen or so well-known English locomotives comprised the importations for

American roads, but data recently discovered by Major Pangborn's representative in England prove that up to 1840 no less than 68 English locomotives were sent here.

The *Stourbridge Lion*, built by Foster, Rastrick & Company, was the first locomotive placed upon a track in this country, but not the first ordered for use here. The *America*, built by George Stephenson, was the first, and it reached these shores ahead of the *Lion*.

An example of the little care and thought given to fact is instanced in the so-called model of the *Stourbridge Lion* in the National Museum at Washington. With the boiler, one of the cylinders and the wheels of the original locomotive in immediate juxtaposition in the museum, the model presents a most peculiar study, inasmuch as it varies so widely from the original in its parts as to cause one to wonder whether the man who designed the alleged reproduction ever gave himself the trouble of following anything but his imagination. Yet the illustration made from this inaccurate model is generally accepted and published as the *Stourbridge Lion*.

As has been stated, no foreign engine was employed or even tried on the Baltimore & Ohio, the ruling disposition of its management being to encourage and develop American genius. To such end it offered in January, 1831, the, for the time, large money prizes for competing locomotives. A striking feature of the engines entering the trial was that not one of the five was copied from the foreign model or was at all like another. While none of them, not even the *York*, the winner, was strictly successful, they evinced the originality and independence ever since characteristic of American builders.

As to the matter of not subsequently following the construction of the locomotives participating in the Baltimore & Ohio trial, the sequel was no different than that of the Liverpool & Manchester competition. With all the fame of the *Rocket*, Stephenson never built another locomotive like it, nor did Hackworth duplicate his *Sans Pareil* or Ericsson his *Novelty*.

All the locomotives entering in the Liverpool & Manchester trial, as well as those taking part in the Baltimore & Ohio trial, will be shown in full-size reproductions.

AMERICAN INVENTIONS.

As development in Europe will be thoroughly depicted, so will American development and progress. The first locomotive in actual service in this country, the first locomotive built here for the first railroad in New York State, the first built by Baldwin, the first built in New Jersey, Rogers's *Sandusky*, the first built by Ross Winans, the first built by the Baltimore & Ohio Company, the father of the standard eight-wheel American locomotive, the first eight-wheel engine built by Ross Winans and the latter's original "camel" locomotive, the first of the type of big fire-boxes will all be shown in full-size reproductions, so that they may be studied in every detail of construction.

Two-thirds of these important historical examples have been completed.

To Ransom C. Wright, of Philadelphia, for a long term of years Chief of the Designing and Drafting Department of the Baldwin Locomotive Works, Major Pangborn assigned many arduous tasks, among them the perfecting of the working drawings for the reproductions of the locomotives in the Baltimore & Ohio trial, and of Ross Winans's first effort.

OLD "GRASSHOPPERS" AND THEIR ENGINEERS.

In the way of original old engines the Baltimore & Ohio possesses the most valued historical examples of American progress in existence. Four of the original grasshoppers are still at Mount Clare, the company's shops in Baltimore, and as none were built subsequent to 1836, not one of the quartette is less than 57 years old. All were in active service until two were recently withdrawn to make the comparatively few changes necessary to restore them to original form, one to correctly reproduce the *Atlantic* (1832), the first "grasshopper," and the other the *Traveler* (1833), the second grasshopper and the first distinctively freight engine built in this country.

The third of the old grasshoppers has just been withdrawn from service in Mount Clare yard; as Ross Winans in 1837 altered a grasshopper by changing the cylinders from vertical to horizontal, and thus created the first of the "crab" type, the *Maseppa*, so will this one be changed to represent the original.

The fourth of the old engines will remain at work in the yard till the middle of April, and then be taken to Chicago just as it is, and shown after 60 years' continuous actual service, its history having been traced back to 1833 as the time she was placed upon the road. This gives it a record without parallel in the world.

It is probable that the only example of the early type of the once noted New Castle locomotive is the *Dragon* (1848), which has been preserved by the Baltimore & Ohio, and the same is quite likely true of the Mason of 1853, which, although condemned to the scrap heap several years ago, was saved from destruction by a thoughtful hand.

WILLIAM MASON.

No man did more for the efficiency and shapely form of the American passenger locomotive than William Mason. That one of his earliest engines still exists is a source of gratification. It and the *Dragon* are both being restored to their original form, as is also the old Perkins ten-wheeler of 1863 and the "600," which was the Baltimore & Ohio's model locomotive in the company's exhibit at the Centennial Exposition in 1876. The Perkins was of the earliest type of the tremendously powerful freight locomotives built by the company especially for service upon heavy grades. The "600," also built by the Baltimore & Ohio, was the first Mogul passenger locomotive constructed.

THE FIRST MOUNTAIN CLIMBER.

An exceptionally interesting and valuable historical locomotive has been contributed to the exhibit by Walter Aiken, President of the Mount Washington Railroad—the original *Peppersauce*, built in 1865, the first locomotive to ascend Mount Washington. It is a rare relic and is now in the hands of the Concord & Montreal Railroad, that company having it in shop for such preparation as may be necessary to show it in complete original form at the Exposition. It will shortly be shipped to Major Pangborn, and with it some of the original rails, so that when seen it will be in position as when ascending, and standing upon the first rails ever rolled for a mountain railroad.

RAILS AND ROAD-WAY.

Throughout the exhibit the examples of motive power will be shown upon the rails and bed of their period, a remarkable amount of original material having been secured. There are on the way from Europe sections of rail, some antedating the present century, used on European tramroads as early as 1790.

In the collection are four of the original rails, with their chairs, etc., upon which the Liverpool & Manchester locomotive trial of 1829 took place, and as the length of track at that time was scarcely more than half a mile, the value of the rails secured may be imagined. An advance of 600 per cent. was offered for them by people in France. The *Rocket* will stand upon these rails. It is the only existing full-size representation of the famous English engine in its original form, the original *Rocket* so carefully preserved in the South Kensington Museum being the remodeled locomotive, largely changed from what it was when the winner of the Liverpool & Manchester prize.

DRAWINGS.

Besides the models of the early locomotives, another feature of the exhibition will be a series of drawings of locomotives beginning with the earliest examples and experiments, and showing the Sail period, the Horse period, the Manual period, the early Traction Power period, the Tramway period, and the Rack system, giving more than a hundred examples, finishing with modern examples of simple and compound locomotives, the latter constituting a showing remarkably complete, as it will include every compound system known.

Other sections of the gallery will contain series indicating progress in connection with the great locomotive manufacturing companies and firms of this country and of Europe, the interest manifested and the co-operation extended by them being of the heartiest character.

CAR EQUIPMENT.

Nothing pertaining to railroad history has apparently been so neglected as the development of car equipment, both passenger and freight. Books have been written, almost any number of them, upon locomotives, but no author has taken up the history of equipment comprehensively and with a determination to establish the facts. The difficulties in the way have been so numerous, the material so hard to get at, as to deter the attempt. It is now, however, being made.

The co-operation of F. E. Stebbins, long the Chief of the Railroad Car Bureau of the United States Patent Office at Washington, has been obtained, and the work already accomplished presages ultimate and unquestioned success.

The leading car manufacturers in this country and abroad have shown the most encouraging interest. Many have been personally visited and induced to have their records carefully searched; and in the end the showing will be a feature of the gallery. The evolution and development will be indicated in a series of large drawings similar to that already described, the set including probably a hundred examples, among them for the first time representations of the early cars on the Baltimore & Ohio, the company placing upon its line the first eight-wheel cars ever run.

RAILROAD APPLIANCES.

As has been said of equipment, so it may be stated of railroad appliances, the history of the inception and perfection of even the most important of them being anything but connected, and thus lacking value for study and comparison. In this country and all over Europe the responses to requests for co-operation by leading manufacturers have been such as to insure that this branch will be striking in every respect.

THE DEVELOPMENT OF THE BRIDGE.

Theodore Cooper will prepare a series of pen-and-ink drawings showing the development of the American bridge; while Clement E. Stretton will complete drawings showing the development of the European railroad bridge.

Mr. Stretton has been Major Pangborn's representative in Europe for months. He is an Englishman of long experience in railroad life, and his earnest, active work has added inestimably to the value of the exhibit. In a recent letter to Vice-President Lord he says:

"Does it not seem strange that there are all these drawings and photographs to be had, yet there is no collection made over here? The first important and the finest collection of the English engines ever made will be that of your company's at Chicago."

RAILS AND ROAD-BED.

The study of the evolution and development of the rail and bed has been long and exhaustive. The work in this line hitherto accomplished, while good as far as it went, very far from covered the whole; and therefore to perfect the series of upward of a hundred different types, which will be illustrated in wash drawings by C. I. Ward, has required much time and laborious sifting of authorities, representations and data.

The great European railroad companies have heartily co-operated in the exhibit, and their contributions of detail drawings and photographs will excite admiration. No such exquisite mechanical drawings have ever been seen in this country, while the photographs of locomotives are upon a scale of such artistic finish as to astonish the few who have been permitted to view them.

Major Pangborn is collecting a superb series of photographs showing exterior and interior views of the royal trains of the world, and original drawings, lithographs, autograph letters and relics generally. He purposes to show at the least one example of every locomotive company or firm that has existed in this country and in Europe. His effort to show photographic scenes of railroad life, motive power, equipment, stations, bridges and the like in every country where a locomotive whistle has been heard has been successful.

From the above description, which does not exaggerate the general scope, extent and interest of this exhibit, it will be seen that no similar collection has ever been made of historical data, relating to the history of railroad engineering. Its value, however, and to a great extent its interest, will depend upon the authenticity of the objects exhibited. Everything should be sacrificed to this. It is, therefore, to be regretted that the artists who have made the drawings which are to form part of the exhibit were not restrained in the adornment of the otherwise admirable drawings with imaginary landscapes. It shakes our confidence in the veracity of the drawing of an old locomotive when it is represented in the midst of surroundings which it is plain had no existence in fact. The interest and value of the exhibit will be due chiefly to its historical veracity and not to spectacular effect. Whatever is imaginary is not history, and detracts from the real value and interest of an exhibit of this kind, in the preparation of which the Baltimore & Ohio Railroad Company have shown so much liberality.

It will be learned with much gratification by those who are interested in the subject to which the exhibit relates, that a record of it, in a sumptuous volume, with excellent illustrations and an elaborate history of the evolution of railroads, by Major Pangborn, is in preparation. The permanent preservation of the collection after the close of the World's Fair is also contemplated.

The Works of the Robert Poole & Son Company, in Baltimore.

THIS establishment is located at Woodberry, a suburb of Baltimore, Md., on the Northern Central Railroad, adjoining the northern limit of the celebrated Druid Hill Park. The founder of the company is Mr. Robert Poole, who has now reached a ripe old age, but is still active in the management of the affairs of the company. He commenced business in a small shop in the rear of a carriage house on Holliday Street, in Baltimore, in 1842, and had the misfortune to be burned out the first night after he started. He afterward associated himself with a Scotchman named Ferguson, under the firm name of Poole & Ferguson. They started in business in 1843 in a shop on North Street, and continued until 1851, doing a general jobbing machine business. In 1851 Mr. Poole bought out Mr. Ferguson, and Mr. German H. Hunt became associated with Mr. Poole, and the firm became Poole & Hunt. They carried on the business in the shop on North Street for some years, but finding it too small, they bought the property which is now occupied by the shops at Woodberry, and in 1851 commenced moving their plant gradually from the North Street shop to buildings which had been erected on the new site. The original purpose was to devote the new shops to the building of locomotives, but when they were ready to be occupied the demand for locomotives had fallen off very much, and there was then little inducement to go into that business. The firm, therefore, continued in their old line—that of general machine business—which has been developed in many different directions. Instead of taking up some one or a few specialties the firm adopted the policy of providing an equipment capable of doing any of those kinds of work which are not made specialties by other establishments, their aim being particularly to do very heavy work for which other shops have not the necessary tools and appliances. In the development and application of machinery to so many and varied purposes, there is constantly a great deal of work to be done outside of the usual lines, and which is necessarily of a more or less original character. When such machinery assumes large proportions, as it often does, few shops are prepared to undertake it. During the past few years this company has been providing shops and a plant capable of handling and doing the heaviest class of work. These appliances will be described further on.

As already remarked, the firms in which Mr. Poole was the leading member did a general machine business. This included stationary steam-engines, which formed a considerable portion of the work before and even after the shops were moved to Woodberry, but of late this branch has received less attention than has been given to it by other firms. Among the work which was done in these shops was sugar, oil, paint, saw-mill, mining, hydraulic and fertilizer machinery, steam fire-engines, chilled car-wheels, coal and street cars. Several brass rolling-mills and white-lead works have been equipped, and the plant for a large number of cable roads has been made here. Quite early in its history the firm made a specialty of

the manufacture of the Leffel double turbine water-wheels. Appliances for furnishing steam or water-power had, necessarily, to be supplemented with the means for transmitting and distributing this power. This naturally led the firm to make a specialty of the manufacture of this kind of machinery of the lightest to the heaviest class—particularly the latter. This includes shafting, couplings, pulleys, gearing, hangers, pedestals, etc., which are supplied for flour and grist mills, cotton and woolen mills, paper and rolling mills, feitilizer and other factories, cable and electric railroads, etc.

It has been remarked in these pages before that the best literature on some technical subjects is the trade catalogues of some firms. The Robert Poole & Son Company have contributed their quota to this kind of publications. They have issued a number of descriptive catalogues relating to the different specialties which they manufacture, which, to persons seeking information relating thereto, will be found very interesting. Their pamphlet on turbine wheels is of this kind and is profitable reading to any one seeking information on that subject. The

given. The list of finished pulleys includes over 800 different diameters and faces. A great variety of hangers, pedestals, base-plates, brackets, etc., are also enumerated. The company keep a large stock of the ordinary sizes of these appliances on hand, which can, for that reason, be furnished promptly. They have also a large assortment of patterns of wire rope transmission wheels or sheaves, ranging in size from 18 in. to 14 ft. diameter.

The facilities of the company for furnishing gearing are also very good. The plant for the production of machine-molded gearing is very perfect, and will produce cast gearing which is equal in accuracy of pitch to cut gearing. The advantage of cast gearing over that which has teeth cut in a machine is that in making the former hard iron of the strongest kind can be used, whereas if the teeth are cut a softer material, which can be readily worked in a machine, must be used. The list of gearing includes over 3,000 different sizes and varieties of spur gearing up to 16½ ft. in diameter, and over 3,500 kinds of bevel and miter gearing. In speaking of the latter, attention is

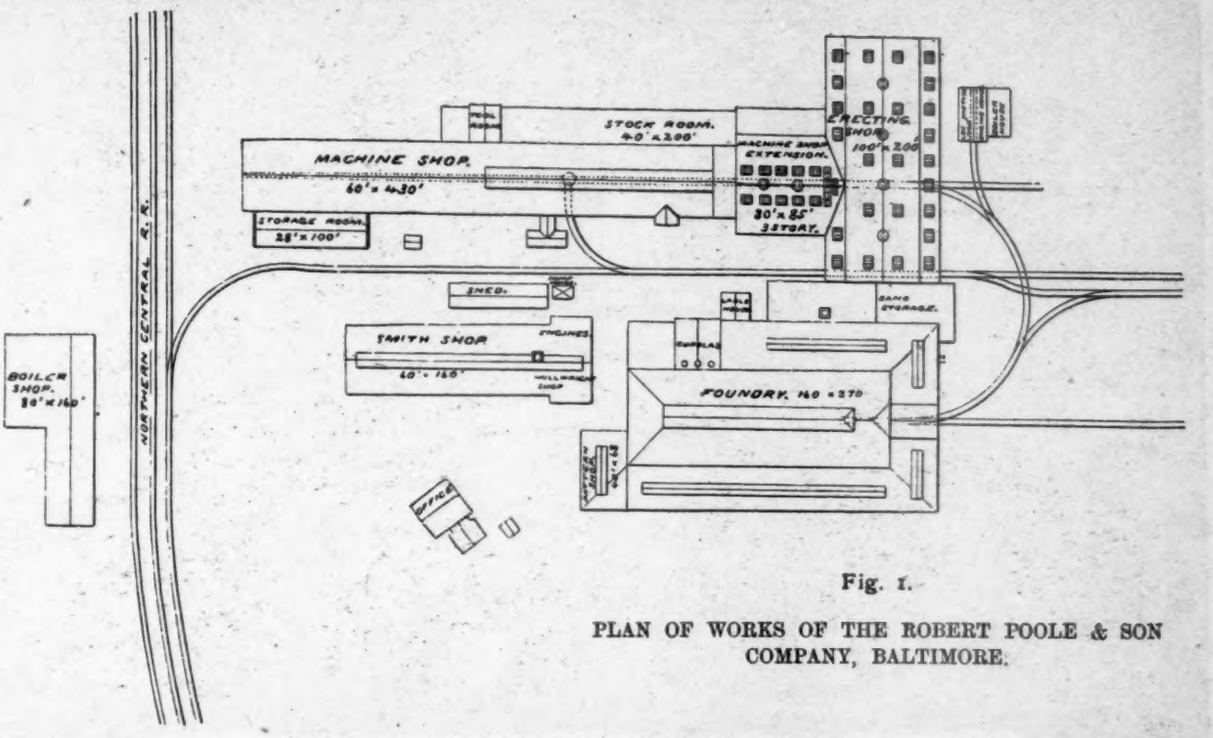


Fig. 1.

PLAN OF WORKS OF THE ROBERT POOLE & SON COMPANY, BALTIMORE.

directions which are given for ordering a wheel, if followed, must lead any one who contemplates doing so to understand the subject much more thoroughly than he would without such specific directions. A diagram showing a section of the wheel, with an explanation of the principles of its action, would be a desirable addition to this pamphlet. The observations about the use of small wheels and their connected machinery is also very suggestive.

The directions in this pamphlet for the measurement of the quantity of water which flows in a stream can be understood by a person of the most ordinary intelligence, and will consequently be of very much greater use than any amount of mathematical gymnastics would be. Some excellent illustrations show very clearly different applications of the wheel. These are followed by a series of tables showing the power, number of revolutions per minute, and also the number of cubic feet of water discharged per minute for each size of wheels under heads of from 3 to 40 ft., which will be found very useful and convenient. Directions for setting the wheels are also given, and further illustrations of various applications of the wheels and methods of arranging the shafting, gearing, bearings and pulleys, on which the success of such motors is often as dependent as upon the wheel itself. Altogether the pamphlet is a very interesting one, and must be especially useful to any one who is either using or contemplating the use of such machinery.

The price-list of shafting, pulleys and hangers which this company has issued will give an idea of the extent of this branch of their business and the facilities which they have for supplying this kind of work. In a table on page 4 a list of pulleys varying from 5 in. to 144 in. in diameter, and from 1 in. to 60 in. face, which includes 101 different diameters, is

called in the catalogue to a fact which is not generally understood. "Miter wheels," it is said, "are bevel gears of equal diameters and number of teeth, with their axes at right angles. The same teeth coming in contact at each revolution tend to increase any variations that may occur in pitch, frequently causing noisy and irregular operation, particularly should two of the teeth not be properly lubricated. An odd tooth in one of the gears serves to change the order of the contact of the teeth, so that the same teeth shall not always meet. These are called hunting-tooth gears, and as they avoid the difficulty above named with true miters, are much more desirable to use when it is at all practicable."

Especial attention has been given by this company to the manufacture of what are called spur and bevel mortise wheels. These are cast-iron wheels which have recesses or mortises cast in them to receive wooden cogs or teeth instead of having iron ones. These mesh into wheels with iron teeth. The iron teeth being stronger than wooden ones, the latter are made thicker than the former, the spaces between the iron teeth therefore being considerably wider than they are when both wheels have iron teeth. Wooden teeth are used for gearing which runs at a very high speed, or which must be noiseless, or both, as the elasticity or yielding nature of the wood resists sudden shocks or jars better than a material as unyielding as iron and with less noise. The teeth are made of hickory or maple wood, which is first thoroughly seasoned and then boiled in paraffine, so as to fill the pores and prevent shrinkage. They are accurately fitted into the openings or mortises in the wheel and are held by dovetailed wedges driven in between the teeth behind the face of the wheel. They are then accurately cut to their required form on a special machine for that purpose. Wheels of this kind 16 ft. in diameter have been

made, and the company is prepared to make them of 25 ft. in diameter.

A variety of internal gears, face mortise wheels, screw or worm, and other gears are described in the catalogue.

The teeth of the larger sizes of gears, which are finished, are generally planed on a special machine for that purpose, instead of being cut with a rotary cutter or milling tool. This saves the expense of the latter, as all that the planing machine requires is a template the shape of the teeth, to guide the tool over the surface of each tooth, while it is being planed.

ERECTING SHOP OF THE ROBERT POOLE & SON COMPANY, BALTIMORE.

For the successful working of heavy machinery for transmitting power good design is of the utmost importance. What constitutes good design can only be known after extended experience. The machinery of a mill or of a cable railroad must run continually, some of it day and night from one year's end to another. It is therefore of the utmost importance that all should be done that is possible to insure durability and security against accident, and to give the maximum strength to the different parts. There is perhaps no firm or company in the country which has had such an extended and varied experience in the construction of this class of machinery as the one whose works are here described. The utmost care is taken to give ample and effective bearing surface for all shafting and have it properly supported and adjusted to sustain the continued wear to which it is subjected. In these shops journal bearings of all large shafts are babbitted, and after being cast in its place the metal is hammered so as to consolidate it and give it density for resisting wear. The bearings are then bored out accurately to fit the shafts.

The plan, fig. 1, herewith, shows the general arrangement of the shops which are located in a valley adjoining the northern limits of Druid Hill Park, in the village of Woodberry, where several large cotton duck mills are located. The plan shows the dimensions and position of the buildings.

In a business in which machinery of new design forms so large a part there must be ample facilities for pattern making. About 20 men are now employed in this department, in a shop which is well lighted and supplied with every facility of doing work accurately. Among the specialties are three cast-iron surface plates 4 ft. × 8 ft. ribbed underneath and planed on top and finished with a true surface. Large protractors are also engraved on their faces, which are used to lay off angles. The convenience of such plates in squaring and laying off work will be apparent.

The foundry is provided with excellent facilities for doing the different classes of work which is turned out by this establishment. This is especially true of appliances for casting, gearing, pulleys, etc. For molding gearing a pattern is made of one tooth including two spaces. This is attached to a vertically movable head of a molding machine, and the flask is placed on a table below which can be accurately turned any fraction of a revolution by a graduating mechanism. The pattern is lowered into the flask and one tooth is molded in the sand. The pattern is then withdrawn and the flask is turned a distance equal to the pitch of the teeth; the pattern is again lowered, and another tooth is molded. This process is repeated until the wheel is complete. Within certain limits wheels of any size and number of teeth can thus be molded on these machines, and with an accuracy equal to that of cut teeth.

Besides the ordinary tools found in all machine shops, this company has the following special tools for doing heavy work: A planer 12 × 12 ft., to plane 30 ft. long; eight boring mills running from 5 ft. up to 12 ft. diameter; special machines for cutting iron and wooden gearing and for doing shafting and pulley work. There are also several machines for planing gears of large sizes.

Fig. 2 is an interior view of the new erecting shop, which is 100 × 200 ft. in size, and is built with a view of being extended northward as business requires it. The engraving will give an idea of the height of the building, which is sufficient to give a clear lift of 54 ft. under the hook of the traveling crane, which has a 60-ft. span and a capacity of 30 tons. The crane was built by William Sellers & Company. The structure is arranged for two such cranes whenever they are required.

The noteworthy machine in this building, parts of which are shown on the right side of the engraving, is the large combined pit and chuck lathe, which has a capacity for turning an object 54 ft. in diameter and 12 ft. face. As indicated by its name, a large part of this machine is below the shop floor and out of sight. We expect, however, to give full engravings of it hereafter. It was designed and built by this company in their own shops.

In the front part of the shop, on the same side as the large lathe is located, is a gear cutter for planing the teeth of gears of any size up to 20 ft. in diameter. The cutting mechanism of this machine can be applied to the large lathe and can then cut gears of 50 ft. diameter.

On the right-hand side of the shop, nearly opposite the big lathe, is a boring mill which will take an object 25 ft. in diameter and 10 ft. high. This was also designed in their own establishment, but the upper part, which is in sight, consisting of the cross head, posts, boring bars, etc., was made by Messrs. Bement, Miles & Company, of Philadelphia. The driving gear, which is very heavy, is all below the shop floor and out of sight, and was made by the Robert Poole & Son Company.

At the further end of the shop is a double-headed lathe of 63 in. swing and 85 ft. long. The heads run independently of each other. The lead screws connected to the two heads are arranged in a very ingenious way, so that they can be connected together, forming a continuous screw extending the whole length of the lathe.

A very important part of the business of this company of late years has been the manufacture of the driving plant for cable railroads. Some idea may be formed of the character, or, as our Yankee brethren would say, the "heft" of this kind of machinery, from the following extract, taken from a description of the cable system operated by the Chicago City Railroad Company on the State Street Line, by H. H. Windsor, the plant for which was built at the establishment herein described. In this description it is said:

"The main driving pinions fastened to the crank-shafts are 6 ft. in diameter and 40 in. face, weighing 32,000 lbs. each. These teeth are staggered, and mesh into those of the main driving gears (also staggered teeth) 10 ft. in diameter, fastened to main shaft. These gears weigh 42,000 lbs. each. They are marvels of the molder's skill, running true, and, considering the great power transmitted, comparatively noiseless, although there has been no machine work done on the teeth, they being left just as they came from the sand. The fly-wheels on the engine crank-shafts are from the same firm; they are 24 ft. in diameter, and each weighs 90,000 lbs. The main line shaft is steel, 16 in. in diameter and 68 ft. long. It is in four sections and revolves in eight bearings. There are two pinions on this line shaft, one 5 ft. and one 6 ft. in diameter, 24 in. face, weighing respectively 12,000 and 13,000 lbs.

"Meshing with each driving pinion is a 10-ft. diameter gear, weighing 26,000 lbs. Said gear is fastened to a shaft carrying a drum on each end. A second pair of drums is carried by a shaft having a similar gear, while between the two there is an idler shaft with a 5-ft. diameter pinion. The drums driven by the 6-ft. pinion on the main line shaft drive their cables one mile per hour faster than those driven by the 5-ft. pinion. These shafts are of steel, 14 in. in diameter and 17 ft. long, resting in pillow-blocks 19 in. in length.

"The drum shafts are 14 in. in diameter and 17 ft. long; they run in three pillow-blocks which are bolted to a heavy cast-iron framework, which in turn is anchored to solid concrete foundations 13 ft. deep.

"The incoming cable passes around its pair of drums with two or three wraps, as the case may require; then leads from the bottom of the drum to the tension carriage, where it passes around the tension wheel from the under side, and leads out into the street, passing around a 12-ft. horizontal sheave, and is afterward elevated to its proper level in the channel. The drums, gears, engines and shafting make an aggregate weight of over 1,000,000 lbs., and occupy a space 151 ft. long and 100 ft. wide."

The following is a list of lines whose plant has been built by the Robert Poole & Son Company: Chicago City Railroad Company, Chicago, Ill. (three plants); Third Avenue Railroad Company, New York, N. Y.; North Hudson County Railroad Company, Hoboken, N. J.; Kansas City Cable Railroad Company, Kansas City, Mo. (two plants); Metropolitan Street Railroad Company, Kansas City, Mo.; Grand Avenue Railroad Company, Kansas City, Mo.; People's Cable Railroad Company, Kansas City, Mo.; Cable Tramway Company, Omaha, Neb.; St. Paul City Railroad Company, St. Paul, Minn. (two plants); Holmes Street Railroad Company, Kansas City, Mo.; Denver City Cable Railroad Company, Denver, Col.; Providence Cable Tramway Company, Providence, R. I.; Los Angeles Cable Railroad Company, Los Angeles, Cal.; Washington & Georgetown Railroad Company, Washington, D. C.; Baltimore Traction Company, Baltimore, Md.; New York & Brooklyn Bridge, Brooklyn, N. Y.; Baltimore City Passenger Railroad Company, Baltimore, Md.

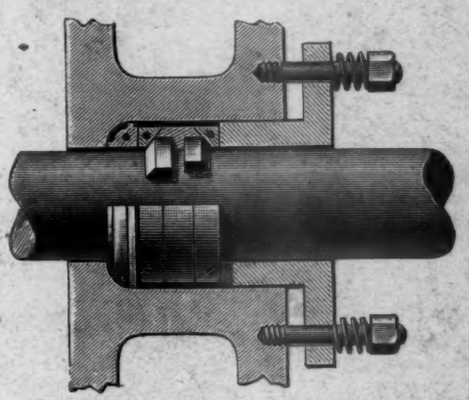
The works herein described are within the city limits of Baltimore, and can be most conveniently reached by the Northern Central Railroad, which passes the entrance to their grounds, and gives them abundant facilities for transportation. As already remarked, the founder of the company, who is still active in its management, is Mr. Robert Poole, who is seconded by his son, Mr. George Poole, under whose management it is safe to predict a continuation of the past success of these works.

Manufactures.

The Forrest Silver-Bronze Packing.

THE accompanying illustration shows a form of packing which has been carefully tested on the rods of stationary, locomotive and marine engines for some two years past, with excellent results. It is claimed for it that it is self-adjusting; not easily deranged; keeps tight by perfect contact instead of excessive pressure; does not bind or crowd the rod; bears lightly and uniformly. It can be applied to any ordinary stuffing-box without change.

As shown in the cut, the packing forms a valve at the bottom of the stuffing-box, preventing steam or water from escaping around the outside, and closes around the rod, preventing leakage from the inside. The whole packing is held on the rod and kept seated by the gland; the springs on the studs outside maintain a uniform pressure and follow up the wear automatically.



THE FORREST SILVER-BRONZE PACKING.

The first brass ring in the bottom of the stuffing-box is the seat-ring; it is put in independently, neatly fitted to the bottom and walls of the stuffing-box and grooved out on the bottom to hold the Usudurian gasket, in which it is imbedded to make it tight.

The next brass ring is ground on to the seat-ring, thus making a tight valve-joint. This ring is made from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. smaller in diameter than the stuffing-box, to admit of lateral motion without touching the walls of the stuffing-box. The rest of the packing, as shown, is of the same outside diameter, and free to move in accordance with the vibrations of the rods.

The outside ring next to the gland is the same shape as the bottom ring (valve-ring), but does not require to be tight at the gland. This ring slides on the gland laterally in the same manner as the valve-ring slides on the seat-ring, to accommodate the vibrations of the rod.

The two inner rings next to the rod are made of silver bronze and take all the wear, and when these rings are worn out they can be renewed, making the packing as good as new without providing any other new parts, as all the rest lasts indefinitely.

The two silver bronze rings are held against the rod by a case made of soft yellow metal.

The case and bronze rings are each put in in two pieces, placed so as to break joints, are provided with suitable dowels to prevent registering, and may be put in and taken out in less time than any other packing.

The seat, valve and cap-rings are screwed together around

LOCOMOTIVE RETURNS FOR THE MONTH OF OCTOBER, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	..	53	39,280	20,688	34,309	134 277	2.911	....	....	63.90	97.56	36.04	76.63	....	....	4.70	4.50	0.30	0.40	3 80	2.00	18.30	....	....	....
Alabama & Vicksburg	....	17	17,871	15,948	10,380	44,199	2,600	....	....	47.73	89.29	47.28	62.69	....	....	6.50	5.20	0.29	0 70	6.10	1.80	20.50	....	....	....
Atchison, Topeka & Santa Fé	834	737	.... ..	.....	417.271	2,391 912	3.246	....	....	...	....	...	87.52	....	...	4.79	7.36	0.28	0.14	6.96	1.49	21.02	....	. ..	1.58
Canadian Pacific	603	...	480,320	963,498	471,995	1.915.813	3,177	..	....	....	....	...	65.19	....	...	3.34	10.93	0.39	....	5 28	1.18	21.10	....	1.72	3 32
Chic., Burlington & Quincy	524	....	.....	.....	.....	2.023.815	3.862	5.24	19.42	....	....	....	84.28	....	....	3.78	5.65	0 22	0.19	6.88	...	16.42	....	...	1 35
Chic., Milwaukee & St. Paul	811	....	.... ..	.....	.....	2.909.962	3.588	....	....	....	....	....	70.40	...	....	3 41	7.38	0.27	...	6.78	....	17.84	....	...	2.05
Chic , Rock Island & Pacific	553	..	573 937	1,096,537	428,173	2,102,647	3.802	....	..	....	....	....	64.60	....	....	2.66	6.11	0.23	....	6.06	0.39	15.45	....	....	...
Chicago & Northwestern	885	....	702,218	1,544,303	838,579	3,085.100	3,486	....	...	....	....	....	88.75	...	....	3.11	7.51	0.35	....	6.34	0.77	18.08	....	....	1.77
Cincinnati Southern	....	99	80,471	171,137	81,413	333,021	3.364	....	..	58 82	116.96	41.82	85.11	..	...	3.90	4 60	0.28	0.60	6.50	1.70	17.60	.. .	....	....
Cumberland & Penn.*	23	22	6,030	38,603	.....	44,633	2,029	....	....	....	....	....	82.64	....	....	3.10	4.37	0.42	....	...	1.76	9.76	....	...	.. .
Delaware, Lackawanna & W. Main L	208	193	.... ..	.....	.....	751.375	3 893	....	....	...	...	....	82.54	....	...	3.78	6.44	0.40	...	5.80	...	15.42	....	....	....
Morris & Essex Division	150	....	170,445	232,922	12,661	414,028	2,617	...	....	....	....	....	67.50	...	...	3.72	10.53	0.40	..	6.52	...	21.17	....	....	3.08
Hannibal & St. Joseph	....	67	73,034	185,809	40,694	299,537	4,537	5.55	17.03	.. .	....	....	81.50	11.74	6.39	3 33	5.90	0.18	0.20	6.50	....	16.11	....	....	1.46
Kansas City, F. S. & Memphis	147	....	102.991	262,055	132,936	497.982	3,387	....	....	...	...	....	60.51	....	...	3 01	4.99	0 31	0.32	7.34	....	15.97	....	...	1.61
Kan. City, Mem. & Birm	41	39	37,169	65,341	. 14.714	117,224	3,006	....	....	....	....	....	65.13	...	...	3 01	3.69	0 23	0.43	7.05	....	14.41	....	....	1.09
Kan. City, St. Jo. & Council Bluffs	....	42	59,060	47,700	50,039	156,79	3,733	5.00	22.04	....	....	....	65.08	13.93	4.21	3 90	5.87	0.14	0.12	6 02	....	16.05	....	....	1.89
Lake Shore & Mich Southern	590	....	437,508	866,901	656,283	1,960,692	3,323	....	....	60.22	84.92	35.37	63.29	....	....	2.87	4.78	13	0.05	6.95	0.19	14.97	....	..	1.51
Louisville & Nashville	...	†347	436,362	831,544	416,812	1,684,718	3,689	5.15	16.28	64.54	109.62	46.26	81.64	12.64	6.50	3.93	6.52	0.26	0.53	6.11	1.55	18.90	3.19	1.41	1.60
Manhattan Elevated	...	283	778,965	.....	53,483	832,448	2,891	....	...	....	....	.. .	42.28	....	....	2.20	8.40	0.30	....	8.80	....	19.70	....	...	3.96
Mexican Central‡	140	118	.....	.....	.....	381,176	3,230	....	..	....	....	....	69.25	....	....	3 95	15.57	0.47	.19	5.45	0.86	26.49	....	....	5.60
Mil., L. S. & Western	112	....	78,988	159 616	100,618	338 622	3,023	....	....	....	....	....	72 41	....	....	3.11	9.93	0.27	....	6.17	0.94	20 42	....	...	2.75
Minn., St. P. & Sault Ste. Marie	....	....	65,081	161,225	65,988	292,294	....	4.45	20.52	...	....	....	67.12	....	....	3.09	11.39	0.21	...	6 42	....	21.11	..	1.59	3.39
Missouri Pacific	349	314	.....	.....	.....	1,230,720	3,919	4.47	17.68	...	....	...	89.09	15.02	6.37	4.78	6.45	0.35	1.18	6.54	1.41	20 71	4.14	1.37	1.44
Mobile & Ohio	107	89	75,103	150,531	62,756	288,390	3,228	....	20.80	....	....	....	61.83	....	....	2.60	4.37	0.20	0 61	5.85	0.94	14.57	....	...	1.43
N. O. & Northeastern	....	93	27,783	57,884	31,619	117,286	3 534	....	....	63.49	102.04	37.11	76.04	....	....	5.10	6.50	0.33	0.60	6.40	1.50	20.50	....	...	....
N. Y., Lake Erie & Western	..	621	402.959	986,750	296,385	1,745.400	2,811	4 60	23 00	87.90	133.10	68.40	....	18.90	5.80	4.44	7.64	0.39	1.86	7.24	1.11	22.10	....	1.60	1.39
N. Y., Pennsylvania & Ohio	....	258	138,363	452,337	150,765	741,465	2.931	5.30	18.50	73.10	114 70	73.20	....	13.50	6.20	3.82	5.68	0.30	2.73	6.76	1.03	20.32	....	1.66	1 15
Norfolk & Western, Gen. East. Div.*	....	143	104,341	288,202	56,361	445.904	3.148	4.80	19.40	....	...	....	102.56	....	...	5.90	3.10	0.70	....	...	....	9.70	...	....	...
General Western Division*	....	122	63.154	250,667	29,494	345,315	2,830	4.70	15.20	....	....	....	122.70	....	...	11.90	3.70	0 70	....	....	....	16.30	...	....	....
Ohio & Mississippi	117	....	141,770	146,969	95,649	384,388	3,285	.. .	....	...	....	....	60.46	...	...	3.36	2.43	0.21	1.14	5.41	1.36	13.91	....	....	0 82
Old Colony	....	230	346.866	131,405	133,314	611,48	2,659	....	.. .	....	....	....	62.95	....	...	3.19	11.59	0.63	....	6.68	0.79	22.88	....	...	3.75
Philadelphia & Reading	....	....	484,494	808,389	622,637	1,915,520	....	....	....	....	....	....	73.13	...	....	4.44	4.89	0.31	....	5.97	0.39	16.00	....	....	....
Southern Pacific, Pacific System	721	....	.....	.. ....	.....	1,740,198	2.414	....	....	....	....	....	70.42	....	....	5.02	17.71	0.41	2 27	7.29	1.19	33.89	...	...	5.11
Union Pacific	991	....	703,939	1,513,666	497,462	2,714 187	2,739	5.77	18.12	....	..	.. .	92.55	13.51	6.80	7.62	8.69	0.40	0 81	7.95	1.04	26.51	4.46	1.77	1.87
Vicksburg, S. & P.	....	14	10,680	10,608	9,780	31,068	2,219	....	....	56.50	89 29	36.63	61.54	....	....	6.90	6.90	0.24	1.40	6.80	3 00	25.20	....	...	....
Wabash	406	357	413 442	799 885	372,361	1,585,588	4,199	5.19	18.02	69.23	104.98	55.34	84.00	13.31	5.83	3.23	4.71	0.29	...	6.39	0.77	15.39	2.64	0.97	1.12
Wisconsin Central	149	131	130.282	286.080	91,393	507,755	3,876	....	....	...	....	....	82.17	....	....	2.95	9.68	0.27	...	7.03	...	19.93	....	....	2.32

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Wages of engineers and firemen not included in cost.

† Number of engines in revenue service only; average mileage is also based on revenue service.

‡ The Mexican Central Railroad reports 18.70 units of work per $1 of expense; 159.00 units of work per ton of coal; 12.58 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

the rod, and never have to be disturbed to renew the packing.

This packing is made by the Forrest Silver-Bronze Packing Company, of No. 115 Liberty Street, New York, from whom further information can be obtained.

The Smith Water-Tube Boiler.

THE two illustrations given show the Smith safety boiler, one of the class known as water-tube or tubulous boilers,

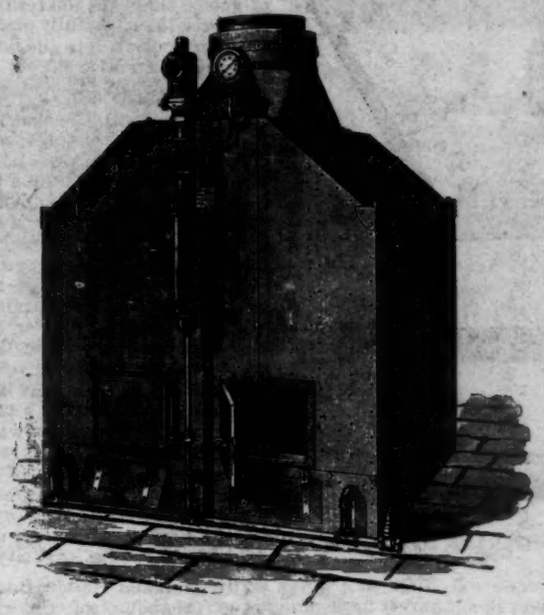


Fig. 1.

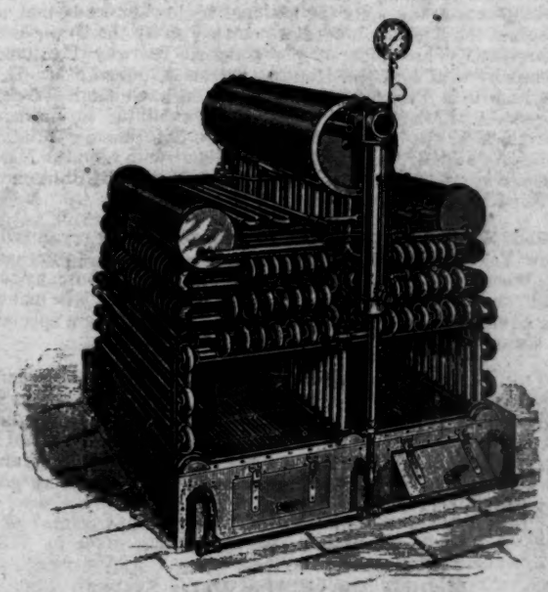


Fig. 2.

THE SMITH WATER-TUBE BOILER.

which are now coming into very general use where high steam pressures are used. Fig. 1 shows the boiler complete with steel casing; fig. 2 has the casing removed, showing the arrangement of the tubes and also the grates. The general design and arrangement, the points in which it differs from other boilers of the same class, can readily be seen from fig. 2.

The manufacturers of this boiler claim for it the following advantages:

1. Freedom and equal circulation of the water throughout every pipe in the boiler; when the boiler is emptied by opening the blow-off cock not a particle of water remains in it.

2. The steam-generating pipes are so arranged that there is no chance for soot or ashes to lodge or accumulate on or between the pipes, there being square openings left up through the entire mass of pipes for the heat and gases to circulate through, the same in effect as in ordinary tubular boilers.

3. The horizontal fire-box pipes are so arranged and supproted by the three (or if so desired, four) vertical pipes that it is impossible for them to sag or drop down even if, through carelessness, they became overheated or red hot. The fire-box is also surrounded at the sides and back of the boiler with a double row of steam-generating pipes, so that the fire has very little effect on the asbestos-lined boiler jacket, and, therefore, very little heat is lost or transmitted to the boiler-room.

4. The feed-water pipes, feed-water heaters and receivers are located on top of the steam-generating pipes, so that the waste heat which will not generate steam may be taken up and utilized in heating the feed water. The feed-water drums are located at the right point, so that they also act as feed-water receivers, or reservoirs, which carry the greatest amount of water just at the point where the water should be kept in the boiler, so that the water will not fluctuate rapidly should the pump or injector not be regulated accurately.

These boilers are made in sections or sizes from 20 to 200 H.P. The Huyett & Smith Manufacturing Company, of Detroit, Mich., are the makers.

General Notes.

THE Dunkirk Engineering Company, Dunkirk, N. Y., recently completed a planer of unusual size for Struthers, Wells & Company, of Warren, O. This tool can plane work 20 ft. in length.

THE Grant Locomotive Works, Chicago, are building 25 heavy 10-wheel locomotives for the Chicago, Burlington & Quincy Railroad.

THE Schenectady Locomotive Works, Schenectady, N. Y., are building nine 12-wheel locomotives with 22 × 26-in. cylinders and 54-in. drivers for the Duluth & Iron Range Railroad.

IT is announced by Messrs. Burnham, Williams & Company, of the Baldwin Locomotive Works, that from January 1, 1893, Messrs. Robert Spencer and Carter H. FitzHugh will act as their representatives for the Northwest, with offices at 1013 Monadnock Building, Chicago.

IN order to provide means for largely increasing its manufacturing facilities and production, the Lunkenheimer Brass Manufacturing Company, of Cincinnati, has been reorganized as the Lunkenheimer Company, with $500,000 capital. The officers are: Edmund H. Lunken, President; C. F. Lunkenheimer, Vice-President and Treasurer; D. T. Williams, Secretary.

THE Ensign Manufacturing Company, Huntington, W. Va., has on hand orders for 325 gondola cars for the Cleveland, Akron & Columbus; 250 box cars and 750 hopper-bottom gondola cars for the Chesapeake & Ohio Railroad.

THE Carlisle Manufacturing Company on December 22 moved into and formally opened its new shops at Carlisle, Pa., a number of guests being present on this occasion. The new shop consists of main building 304 × 100 ft., with wings for the shipping department and boiler-room. The power is furnished by a Corliss engine of 150 H.P. The new shop is fully equipped with tools and is very conveniently arranged for handling the work.

THE Baldwin Locomotive Works in Philadelphia turned out 670 locomotives in 1892. Of that number, 210 were compound engines of the Vauclain type.

THE Automatic Electric Signal Company has been organized in Indianapolis to make and introduce a system of signaling between trains devised by Mr. B. C. Seaton, of Nashville, Tenn. In this system the inventor uses a light third rail laid between the two ordinary rails. Under each locomotive is a contact wheel running on the center rail; the latter is broken into short open circuits, so that the approach of trains, either from different directions or the same direction, will close the circuit, and in doing so cause a bell to ring on each engine as a danger signal.

THE Baldwin Locomotive Works are to build 20 consolidation engines of the Vauclain compound type for the Norfolk & Western Railroad. They will have cylinders 14 and 26 × 24 in. and 56-in. driving-wheels.

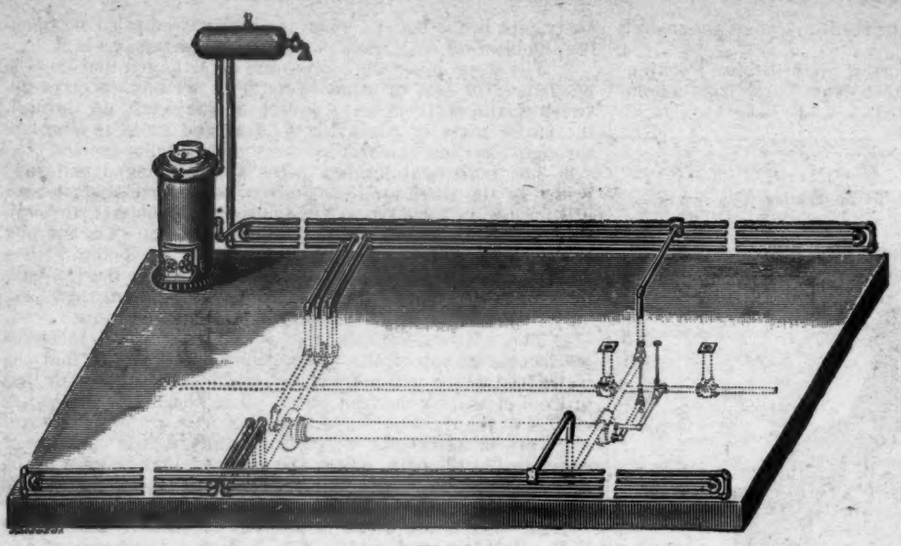


Fig. 1.

Fig. 2.

Fig. 3.

MULTIPLE CIRCUIT HOT-WATER SYSTEM.

THE Rhode Island Locomotive Works in Providence are to build 12 heavy passenger engines for the Boston & Albany Railroad. Six of these engines are to be of the ten-wheel type, with six drivers coupled.

THE National Car Spring Company, of New York, and the Oswego Railway Spring Company have been consolidated. The new organization will be known as the National Railway Spring Company, and its officers are: Theodore Irwin, President; Thomas M. Bell, Vice President; George B. Sloan, Jr., Secretary and Treasurer; Edward A. Cliff, Superintendent. The factories at Newark, N. J., and Oswego, N. Y., will be continued for the present, but the company purposes building an extensive plant in Buffalo, N. Y., as soon as possible.

THE St. Charles Car Company, St. Charles, Mo., are building for the Missouri Pacific Railroad four 60-ft. postal cars with six-wheel trucks, finished in accordance with the standard postal regulations; 10 chair cars very handsomely finished, having large double windows, smoking and wash-rooms and provided with the latest pattern of Scarritt reclining chairs; 20 first-class passenger cars, 55 ft. long, with smoking-rooms, and fitted with Scarritt-Forney high-backed seats. All these cars are handsomely finished; they have the Safety Car Heating and Lighting Company's steam heating system and are lighted with gas on the Pintsch system.

THE New York Safety Car Heating & Lighting Company has just completed a plant at Council Bluffs, Ia., and is ready to supply gas to any companies desiring it. It has a capacity of 20,000 ft. per day. The company's Kansas City plant will be in operation in a few days. It is also building plants at Toledo, at Buffalo and at Chattanooga, Tenn. There is besides a plant under construction at Portland, Ore., and one at Oakland, Cal. These will all be in operation inside of three or four months.

THE Union Pacific Railroad is equipping all its cars with the Safety Company's systems of heating and lighting as fast as the cars under o repairs at the shops; so also is the Missouri Pacific.

THE Philadelphia office of the Pittsburgh Testing Laboratory of Hunt & Clapp has been discontinued, and all business will be done hereafter at the headquarters in Pittsburgh.

THE Hon. T. H. Anderson, United States Minister to Bolivia, says, in a recent letter to the Department of State, that the industry of working wood by machinery is a growing one in South America, and the trade for all classes of wood-working machinery is given to the United States. And he further says that the Egan Company, of Cincinnati, O., controls over 50 per cent of this trade in this class of goods, simply as the result of enterprise in successfully placing superior goods before the South American buyers.

THE firm of Booth, Garrett & Blair, Analytical Chemists, in Philadelphia, have established a department in their laboratory for the mechanical testing and inspection of iron, steel and other metals. The class of work that they propose to undertake will include not only rails, structural and bridge material, but also railroad equipment and supplies, water-pipe, and all similar material subject to specifications and tests, chemical or physical. To carry out this plan they have associated with them as a partner, Mr. F. H. Lewis, known as an expert in this specialty, who will have general charge of the department. They are also adding to the physical laboratory a modern high-speed testing machine of 100,000 lbs. capacity.

THE National Hollow Brake-Beam Company, of Chicago, has leased its entire business, plant and patents to the Chicago Railway Equipment Company, which company from January 1 manufactures and sells the national hollow brake-beams, and assumes the business heretofore carried on by the Brake-Beam Company. The office of the Chicago Railway Equipment Company is at 40th and Hopkins Streets, Chicago. Mr. H. S. Burkhardt is President and E. B. Leigh, General Manager. Messrs. A. J. Farley and L. C. Burgess will be in charge of the sales in the West, with office No. 514 Phœnix Building, Chicago, and Mr. F. G. Ely in the East, with office at No. 29 Broadway, New York, as heretofore. Mr. H. B. Robischung is Superintendent of the works.

THE Manhattan Equipment Company, recently organized in New York by Mr. H. M. Warren and associates, has purchased the business of the firm of Reginald Canning & Company, and will conduct it hereafter. Mr. Thomas B. Inness will manage the equipment department of the business, making a specialty of second-hand cars and locomotives.

THE W. & A. Fletcher Company, New York, has ordered 1,840 tubes of the Servé ribbed pattern for the 10 boilers for the new steamer building for the Fall River Line. The boilers are of the Scotch type, 14 ft. in diameter and 14 ft. 6 in. long, and each will have 184 of the Servé tubes, 3½ in. in diameter and 10 ft. 3½ in. long. These tubes have made a very good showing in service.

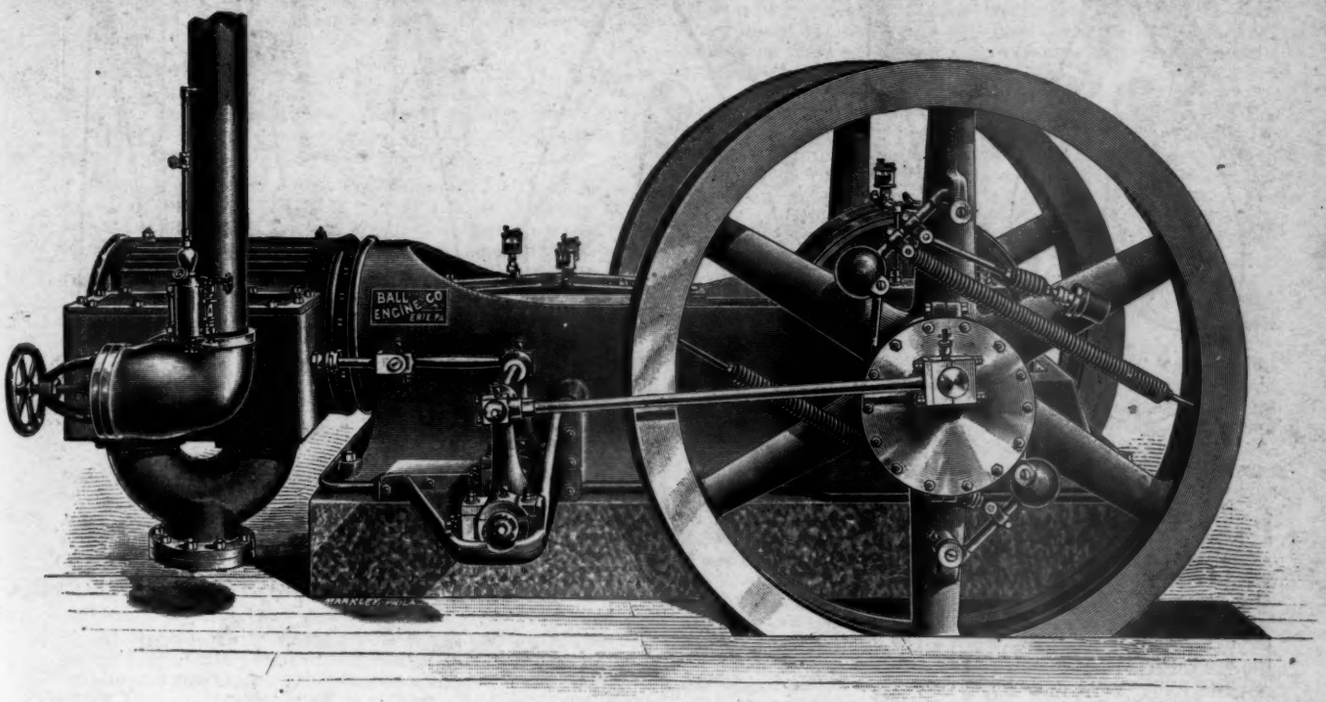
Multiple Circuit Hot-Water System.

A NEW hot-water circulating system recently patented and put into service by the Consolidated Car Heating Company is known as the multiple circuit system.

The multiple circuit is a drum system which meets the demand for a sufficient heating surface for the largest cars. The steam pressure required is 4 lbs. There is no practical limit to the amount of heating surface which may be provided, the heating pipes being divided into eight or more different circuits, which are connected to the same source of heat. All parts of the car receive the heat from the different circuits simultaneously and in the same degree.

The circuit is through the two upper pipes to both ends of the car and returning to the center through the two lower pipes, where the water enters through a 2-in. pipe the return end of the heating drum. The construction of the drum is shown in figs. 2 and 3, which show four 1¼-in. corrugated copper pipes attached to the cast-iron head before the drum is put together.

The body of the drum, shown in fig. 3, is a wrought-iron pipe 5 in. in diameter, the pipe connections being made through the cast-iron heads which enclose the end of the drum. There are two ports in one of the heads. Through the upper one the steam is supplied to the interior of the corrugated pipes within the drum; the lower port is for removing the water of condensation. The four pipes of corrugated copper have a total length of 35 ft. and are arranged in two separate steam circuits. The water of all circuits flows the entire length of the drum. Steam from the train-pipe is admitted into the corrugated pipe, and the water is heated by contact with the external surface of this pipe. The drum beneath the car is placed against the needle beam. Fig. 1 shows the general arrangement of the piping and drum in this system.



NEW ELECTRIC RAILROAD ENGINE.

An Engine for Electric Work.

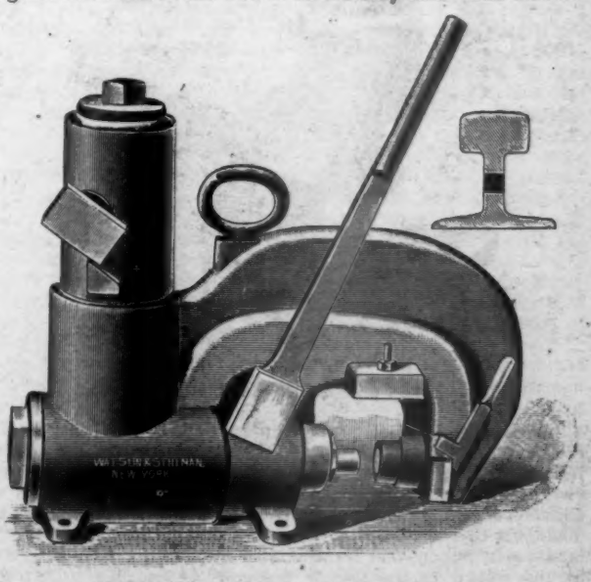
THE illustration herewith shows a new engine designed for the severe work required on electric railroads, for electric welding, etc., by the Ball Engine Company, of Erie, Pa. It is intended to meet the requirements of heavy duty, varying loads and long continuous runs, and seems well adapted for service of this kind.

The frame of the engine is massive and heavy and internally ribbed, so as to give the greatest attainable stiffness. The crank-shaft is forged out of a solid steel ingot of the best quality, and is of large diameter and great strength. The connecting rod and straps are forged out of steel ingots and are of a new design, combining strength with efficiency. The main bearings are unusually large, and are so arranged that both the vertical and side wear of the liners may be taken up. The main bearing liners are genuine babbitt, carefully scraped and fitted, and as they are made removable, they can be quickly and easily taken out and replaced with new ones if necessary. The crank-pin boxes are lined with genuine babbitt. The cross-head boxes are made of pure copper and tin. The cross-head is a steel casting with very large bearing surfaces, and is babbitted on the four faces with genuine babbitt. The cross-head pin is tool steel, and the piston-rod a fine quality of crucible steel. The oiling devices are of the most improved form, and all fittings are complete and of the best description. The regulation by means of the improved governor is such that the engine has shown in practice excellent regulation under conditions where the variation in load on the generator from zero to the full capacity has occurred in less than five seconds of time.

It may be added that great care is taken in building these engines to secure good workmanship in all the details.

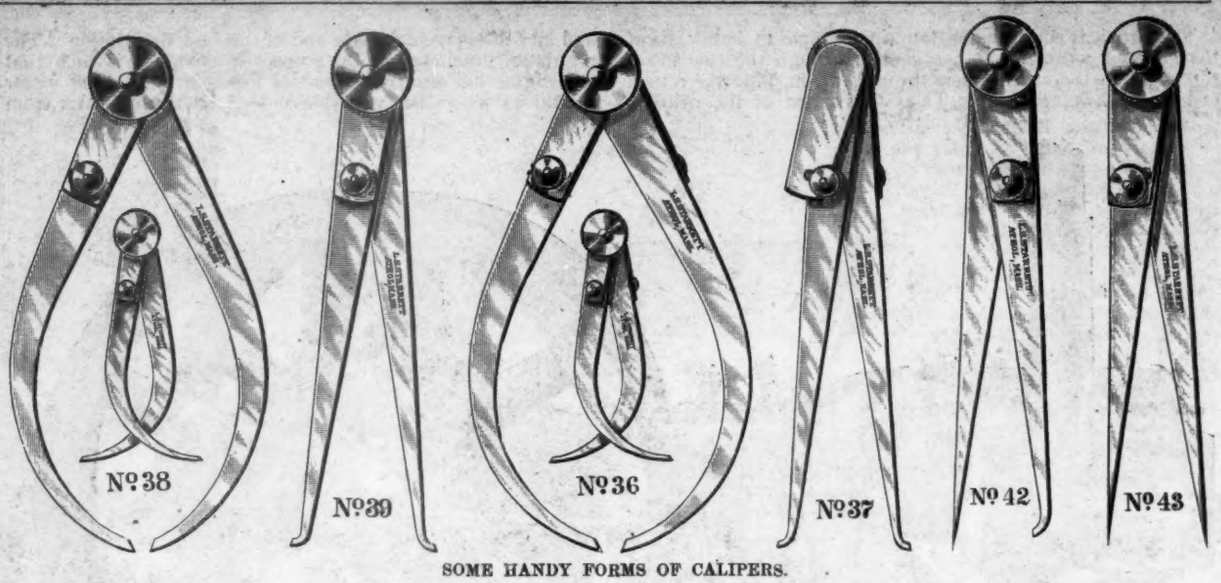
Some Hydraulic Rail Punches.

THE accompanying cut shows a hydraulic punch for making the bolt holes in the web of an ordinary rail. The makers claim that these punches are the first made which can be conveniently used by an ordinary gang of men, and which do not require to have the rail removed from the road-bed in order to punch it.



HYDRAULIC PUNCH FOR WEB OF RAIL.

By the use of the quick-acting lever, shown in the middle of

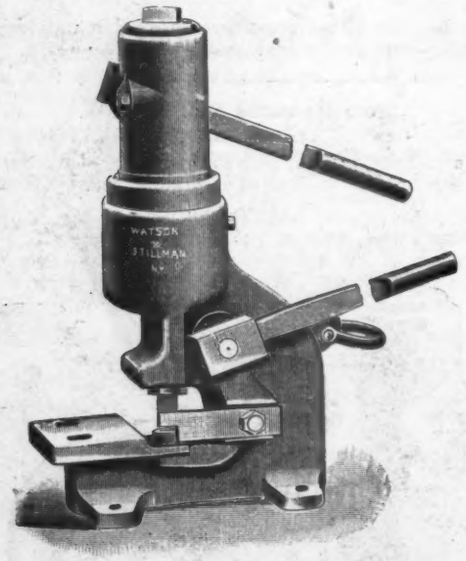


SOME HANDY FORMS OF CALIPERS.

he cut, the ram may be worked in and out a distance of 2 in. without the loss of time and labor of pumping. In mounting the die in a sliding bolster, which latches it in position, an additional opening is obtained without the extra weight which would be necessary to get a 4-in. movement, and also a reservoir of sufficient capacity. A guide is placed at the top of the jaw which, once set for any pattern of rail, will cause all holes to be punched at the same height. In returning the punch to the cylinder the pumping socket must be brought down against the head lug before the quick-working lever can be used.

These punches are made in two sizes, for 70-lbs. and 90-lbs. rails. The makers are the well known firm of Watson & Stillman, of New York.

The second illustration shows a tool by the same makers,



HYDRAULIC PUNCH FOR SPIKE-SLOT OF RAIL.

which is an adaptation of their improved hydraulic punch, for the purpose of punching the spike-slots in the base of heavy rails for regular railroad service, as is frequently required on switches and curves; it is the first tool of the kind which is convenient, expeditious and reliable, making a clean-cut slot. The body of the punch is somewhat longer than in the regular style of punch, and is cut out in front to bring the center of the punch to the proper position. As in the improved hydraulic punch, this punch may be brought down to the work without the labor of pumping, being both raised and lowered by the lower lever shown in the illustration. They are very carefully designed to avoid the troubles which formerly existed in the punches of this character. The head is of the same construction and size as in the corresponding sizes of the regular make of punch. No. 2, with 1½-in. jaw, weighing about 90 lbs., has sufficient power to punch the $\frac{11}{16} \times \frac{11}{16}$ slot in the side of the base of a 90-lbs. steel rail. Guides are placed on the side for determining the depth, and also act as strippers.

Some Handy Tools.

THE illustrations given show a series of exceedingly handy tools of new patterns, devised and made by Mr. L. S. Starrett, of Athol, Mass., who is well known as a maker of machinists' tools.

Nos. 38 and 39 show outside and inside calipers, called by the maker lock-joint calipers. They are of wide scope for both inside and outside work, can be instantly adjusted to their full extent, and as quickly locked firm in the joint, and are yet provided with a sensitive adjustment They are made to supersede the old style firm joint, also the lock joint with split-leg adjustment. The improvement consists, first, in a socket joint made tapering, and locked or released by a partial turn of the knurled disk drawing it together. A spring washer under the disk maintains an easy friction in the joint when unlocked. In the under side of the short arm is a slot containing a stiff spring. Riveted into the middle leg and projecting through an opening in the arm is a *threaded stud* on which is a knurled nut having a beveled hub—this bears against a cone in the arm; the action of the spring holding them together turning the nut, presses them apart and adjusts the leg while the joint is locked. The spring taking up all back-lash, the legs are firm.

These calipers are made in sizes from 4 in. to 24 in.

Nos. 36 and 37 show the lock-joint transfer calipers. They are an improvement on the preceding patterns, as in addition to the ordinary use they may be employed to take measurements inside of chambered cavities, over flanges, etc., and may be removed and replaced without losing the size calipered. This is done by loosening the nut, binding one arm to the auxiliary leaf and swinging it out or in (while the joint is locked) to clear the obstruction, then moving it back against a stop, where it will show the exact size measured.

Like those first described, these calipers are made in sizes from 4 in to 24 in.

No. 42 shows a very handy pair of hermaphrodite calipers with lock-joint and sensitive adjustment. These are made in 6 in., 8-in. and 10-in. sizes.

No. 43 shows a pair of dividers with the Starrett lock-joint attachment and sensitive adjustment. They are light and stiff, with large capacity, instantly opened, closed and locked. The points are nicely tempered. They are made in 6-in. and 8-in. sizes.

THE report going the rounds a few weeks back in regard to the Baltimore & Ohio making a heavy increase in the freight equipment seems to have had its origin in the fertile brain of a newspaper reporter; but it is understood there will be some new cars contracted for in the near future, the exact number not being yet decided on. The policy of the company is to improve its equipment by rebuilding the old, short cars, and make them standard length, using the old materials.

PERSONALS.

FREDERICK H. LEWIS has resigned his position as Manager at Philadelphia for the Pittsburgh Testing Laboratory, and has taken an interest with Messrs. Booth, Garrett & Blair, of Philadelphia, in a department of mechanical testing and inspection.

CHIEF ENGINEER NATHAN H. TOWNE, U. S. N., for some time past Chief Assistant in the Bureau of Steam Engineering, has been granted leave of absence for two years. During that time it is understood that he will act as Consulting Engineer at the Cramp Yards in Philadelphia.

JAMES MACBETH has been appointed Master Car-builder in charge of the Buffalo shops of the New York Central & Hudson River Railroad. He was formerly in charge of the locomotive shops at Buffalo, but more recently has been Superintendent of Motive Power of the Adirondack & St. Lawrence Railroad.

EUGENE CHAMBERLAIN has resigned his position as Master Car-Builder of the New York Central & Hudson River Railroad to undertake the management of the Lancaster Malleable Iron Works as a partner. He has been connected with the New York Central for 18 years and for eight years has had charge of the Buffalo shops.

CHRISTOPHER BENSON, who is 86 years old, and is now an inmate of the Philadelphia Hospital at Blockley, can claim to be one of the first locomotive engineers in the country. He was employed on the old Mohawk & Hudson Railroad in 1829, and ran the old *John Bull* and the *DeWitt Clinton* on that road. He was for many years on the New York Central, but advancing age forced him to give up work several years ago.

COMMODORE FOLGER'S retirement from the position of Chief of the Bureau of Ordnance, Navy Department, leaves a vacancy which has been filled by the appointment of CAPTAIN WILLIAM T. SAMPSON, for some time past at the Washington Navy Yard. CAPTAIN JOHN A. HOWELL is made commandant of the Washington Yard, and COMMANDER T. F. JEWELL Superintendent of the Gun Factory. COMMANDER GEORGE A. CONVERSE succeeds Commander Jewell in charge of the Torpedo Station.

JOHN FRITZ, Chief Engineer and General Superintendent of the Bethlehem Iron Works, relinquished the duties of Superintendent at the close of the old year. He has been succeeded in that position by OWEN LEIBERT, who has been for many years one of his assistants. Hereafter Mr. Fritz will act as Consulting Engineer of the works. Mr. Fritz built the Bethlehem Works from the first blast furnace to their present splendid proportions. He was appointed the Superintendent of the works on June 20, 1860, coming to Bethlehem from Johnstown, where he had been Superintendent of the Cambria Iron Works. Other important changes in the staff of the Bethlehem works occurred at the close of 1892. RUSSELL W. DAVENPORT, the Assistant Superintendent, becomes Second Vice-President of the company. ROBERT H. SAYRE, JR., assumes the position of Assistant Superintendent. ALBERT LADD COLBY, Head Chemist, will hereafter be Superintendent of the blast furnaces.

OBITUARIES.

HORACE SMITH, who died in Springfield, Mass, January 15, aged 83 years, was born in Cheshire, Conn., and received his mechanical training in the United States Armory at Springfield, Mass. He made some important improvements in the machinery used there, and later, in connection with D. B. Wesson, invented the Winchester rifle and the Smith & Wesson revolver, both of which are well known. He retired from business a number of years ago with a moderate fortune, and has since lived quietly in Springfield.

EDWARD H. MARTIN, who died in Cleveland, O., December 29, was born in England in 1832. He received a liberal education, gaining the degree of civil engineer, and he engaged in many large manufacturing enterprises in his native land. In 1868 he came to this country, and the following year acted as Assistant Engineer in superintending the construction of the bridge over the Ohio River at Louisville. In 1870 he supervised the construction of the Reese Agricultural Works at Mansfield, in that year inventing one of the first automatic horse-rakes ever manufactured. In 1872 he removed to Cleveland and built the Union Steel Screw Works, holding the position of Constructing Engineer. In 1874 he entered the employ of the Cleveland Rolling Mill Company, remaining there until 1891. While with that company he designed all the machinery that was put up in the works, including boilers, engines, pumps and all varieties of work. He invented an improved pumping engine which, under the name of the Martin pump, became known everywhere. In 1891 Mr. Martin entered the service of the Baackes Wire Nail Company, remaining there until his death. During this period he built the Baackes rod mill.

H. STANLEY GOODWIN, who died in Bethlehem, Pa., December 25, aged 60 years, was born in Morris, Conn. He began his railroad service in 1852 as a rodman on the Delaware, Lackawanna & Western, and was Chief Assistant Engineer of that road from June, 1853, until March, 1857. For a year after that he was Principal Assistant Engineer of the Honduras Interoceanic Railroad. From November, 1858, to June, 1860, he was Resident Engineer of the Western Division of the Pittsburgh, Fort Wayne & Chicago. During the early years of the War he was Superintendent of the Catawissa Railroad, and from April, 1863, to April, 1866, he was Chief Engineer of the Northern Central. He then moved to Bethlehem, and from April, 1866, to December, 1882, was General Eastern Superintendent of the Lehigh Valley. For the last ten years he has been General Superintendent of that road, and when it was leased by the Philadelphia & Reading, President McLeod recognized his value and appointed him General Eastern Superintendent of the Philadelphia & Reading. He was affectionately regarded by the railroad men under his charge and by his townspeople. He was an instructor in civil engineering at Lehigh University in 1868 and 1869, under Dr. Coppee's administration as President.

GEORGE FRICK, the founder of the Frick Company, of Waynesboro, Pa., died in his home at that place on Friday, December 23. His wife and four sons survive him. He was born in Lancaster County, Pa., on November 25, 1826, and was 66 years of age. He was a son of Alvam and Catherine (Diffenbaugh) Frick, natives of Lancaster County and of German descent. He was the fourth of a family of six children, was raised on a farm, and, like thousands of other American boys, received his education in the common schools. When he was eleven years of age his father removed to Franklin County, Pa., where he grew up on the farm. He learned the trade of a millwright, and followed the business for a few years. When quite a young man he conducted a repair shop at Quincy, and built grain drills or seeding machines. In 1850, after his marriage, he removed to a farm near Ringgold, where he erected a shop and began building the Frick engine, which he invented. Shortly after he rented another shop and added to his business the building of the Geiser threshing machine, which has had a great reputation through all that region of country. He and Peter Geiser then became associated together, and the result has been the creation of two large establishments in Waynesboro—one, the Frick Company, for the manufacture of steam-engines of various kinds and sizes, ice-making and refrigerating machines, saw-mills, etc.; the other, the Geiser Manufacturing Company, which is making agricultural machinery. In the early fifties Peter Geiser, a farmer's boy, scarcely out of his teens, perfected and tested his threshing machine and separator. Mr. Frick was then operating his shop near Ringgold, and come most serviceably to his young friend and collaborator's assistance in furnishing him with the castings for his machine. Thus the two industries sprang from the same period, the same location, and have since continued an association and development along equal lines of struggle and triumph. They are to-day the twin factories of which Waynesboro is justly proud.

In the year 1858 Mr. Frick, finding the scope of his market quite outgrowing his facilities, and induced by appeals from certain of his fellow-citizens, concluded the purchase of a piece of land now the site, in part, of the present Geiser works. In the following year he erected a large frame shop and foundry, together with a residence, hard by. In 1850 he moved his plant from Ringgold in and began the operation of his new and larger works. This same year Mr. Frick made an arrangement with Peter Geiser, who had been receiving overtures from Greencastle parties to locate his works there, to manufacture his threshers at the new works. This arrangement was the beginning of a movement which finally resulted in the concentration of the various branches of the Geiser separator works—eight in number at that time—in Waynesboro.

Mr. Frick conducted this enterprise with yearly increasing success till 1866, when the separator branch of the business passed into the hands of the firm of Geiser, Price & Company, who purchased the works. Mr. Frick, this same year, pur-

chased a parcel of land just across the street, where he erected the large and well-planned brick shops now occupied by the American Manufacturing Company. Here he continued to conduct the business of engine building till 1873, when the partnership of Frick & Company was formed, to whom he sold his interest in the works. He remained with the enterprise in the capacity of Superintendent till 1888, when from declining health and vigor he was compelled to resign. Since that time, with the exception of a year's connection with the American Manufacturing Company, for whom he invented their valuable simoon evaporator, he has led a life of well-earned retirement and rest.

In the October (1892) number of this JOURNAL an elaborate description of the present works of the Frick Company was published. These now rank among the first of their kind in the country.

The *Keystone Gazette*, a local Waynesboro paper, to which we are indebted for most of the particulars of Mr. Frick's life, said of him that "his life was a busy one, and his nature, though gentle as that of a child, was of heroic mold. Otherwise he could not have struggled up from comparative obscurity through all the adversities and discouragements that beset effort, especially upon new lines, to the parentage and headship of one of the largest and most flourishing industrial establishments of the land. Nature had endowed him with the spark of inventive genius, but the flame that finally lit his pathway with honor and renown was the result of work, persistent application, determination to succeed, trial, drudgery and sacrifice. In this school of discipline his faculties were sharpened, and when in the zenith of his career his executive ability and capacity for grasping complicated details were of the highest order."

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the meeting of December 21 Mr. U. H. Broughton read a long paper on the Shone Hydro-Pneumatic Sewerage System, describing various applications of this system. This paper was briefly discussed by members present.

AT the regular meeting, January 4, a paper by A. J. Grover, on Flood Waves in Sewers and their Automatic Measurement, was read and discussed.

Mr. E. B. Dorsey described the Harbor Improvements at Tampico, Mexico, as now in progress.

The following elections were announced:

Members: John W. Alvord, Chicago; James Francis, Lowell, Mass.; Alfred Rosenzweig, City of Mexico; Henry G. Ruttan, Winnipeg, Manitoba.

Associate Members: S. B. Miller, Hoboken, N. J.; Kennerley Bryan, Chicago.

THE officers elected at the annual meeting for 1893 are: President, William Metcalf; Vice-Presidents, Charles Macdonald and E. L. Corthell; Directors, Foster Crowell, Henry G. Prout, Willard S. Pope, F. P. Stearns, J. T. Fanning and O. S. Landreth; Secretary, Francis Collingwood; Treasurer, John Bogart.

American Forestry Association.—The annual meeting was held at the Department of Agriculture, Washington, D. C., December 20. Mr. B. E. Fernow, Chairman of the Executive Committee, presented his report, in which it was stated that there are at present six reservations of forest, representing a total of 3,252,260 acres. These are as follows: White River, Pike's Peak and Plum Creek, Colorado; Pecos and Canadian River, New Mexico; Bull Run, Oregon; and Yellowstone National Park timberland reserve, lying south and east of Yellowstone Park, Wyoming. A public State park was proclaimed last August at Lake Itaska, Minn., headwaters of the Mississippi River. There are 26 proposed forest reservations now being considered which are situated in California, Colorado, Idaho, Minnesota, Montana, New Mexico, North Dakota, Oregon, Washington and Wyoming.

There was an animated discussion on the merits of the Paddock bill, now on the Senate calendar, which proposes to place the control of the timber lands in the hands of the Secretary of Agriculture, who will be given administrative action in order to protect and utilize the timber. The proposed reservations are not land desired for agricultural purposes.

The following officers were elected for the ensuing year: President, Hon. Sterling J. Morton, Arbor Lodge, Neb; Treasurer, Henry M. Fisher, Philadelphia, Pa.; Secretary, Dr. N. H. Egleston, Department of Agriculture, Washington, D. C.; Corresponding Secretary, J. D. W. French, Boston, Mass.; Chairman of Executive Committee, B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, Washington.

Master Car Builders' Association.—The Committee on Attachment of M. C. B. Couplers to Cars has issued circulars requesting manufacturers of M. C. B. type couplers and of draft devices for cars to submit detail drawings or blue prints of their couplers or other devices to the Committee, accompanying them with full descriptions. These should be sent to the Chairman, Mr. E. D. Bronner, whose address is "Care Michigan Central Railroad, Detroit, Mich."

American Society of Naval Engineers.—The officers elected at the recent annual meeting in Washington are: President, Chief Engineer H. Webster; Secretary and Treasurer, Passed Assistant Engineer W. M. McFarland; Members of Council, Assistant Engineer W. W. White, Passed Assistant Engineers F. H. Bailey and J. N. Hollis.

Civil Engineers' Society of St. Paul.—At the annual meeting in St. Paul, January 9, resolutions of thanks for courtesies received on the recent excursion to West Superior and Duluth were adopted.

The following officers were elected: President, George L. Wilson; Vice-President, J. D. Estabrook; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. Münster; Representative on the Board of Managers of the Association of Engineering Societies, C. J. A. Morris.

The President made the following appointments: Examining Board, C. F. Loweth, A. O. Powell and E. E. Woodman; Auditor, W. C. Merryman.

Mr. J. J. Sewall gave a description of the Marshall Avenue Bridge over the Mississippi; and Mr. W. H. Wood spoke of his Experience on the Mexican Southern Line.

Engineers' Club of Cincinnati.—The fifth annual meeting was held December 15, with 31 members present. The reports of the Secretary and Treasurer were presented, showing the Club to be in a satisfactory condition. The following officers were elected to serve during the coming fiscal year: President, Colonel Latham Anderson; Vice-President, W. B. Ruggles; Directors, M. D. Burke, Charles A. Ewing and H. L. Hoeffer; Secretary and Treasurer, J. F. Wilson.

The retiring President chose for the theme of his annual address, Ethics of Engineering, which he treated very thoroughly and understandingly. His paper was ordered printed for distribution. The customary annual lunch was served.

Western Society of Engineers.—At the annual meeting, in Chicago, January 4, the following officers were elected for the ensuing year: President, Robert W. Hunt; Vice-Presidents, H. A. Rust and H. B. Herr; Secretary and Librarian, John W. Weston; Treasurer, F. G. Nourse; Trustee, George S. Morison.

Northwest Railroad Club.—At the annual meeting in St. Paul, January 10, the following officers were elected: President, William McIntosh; Vice Presidents, John Hickey and E. A. Williams; Secretary, W. D. Crossman; Treasurer, H. L. Preston.

Southern & Southwestern Railroad Club.—At the last meeting, in Atlanta, Mr P. W. Gentry described the system used on the Richmond & Danville Railroad for regulating the consumption of oil on locomotives.

The following officers were elected: President, Pulaski Leeds; Vice-Presidents, James Meehan and A. W. Gibbs; Treasurer, A. G. Steinbrenner; Secretary, S. A. Charpiot.

Master Mechanics' Association.—Secretary Angus Sinclair issued the following circular under date of December 27, 1892:

ANNUAL CONVENTION.

The Twenty-seventh Annual Convention of the American Railway Master Mechanics' Association for 1893 will be held at Lakewood, N. Y., with headquarters at the Kent House, commencing Monday, June 19, 1893.

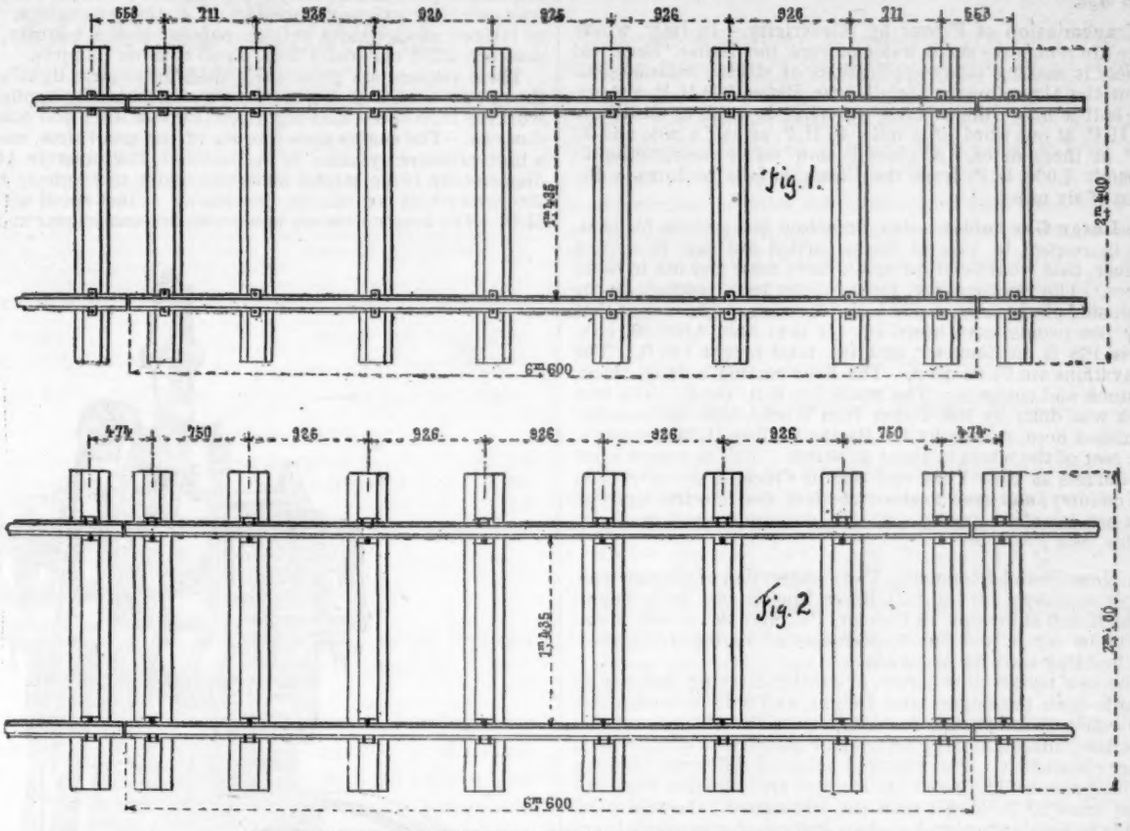
There are two hotels close together, and the proprietor of the Kent House will receive all applications for rooms and locate the guests. His address is John C. Brady, Kent House, Lakewood, on Chautauqua Lake, N. Y.

The hotels agree to a uniform rate of $3 per day, when nothing extra is wanted.

Messrs. R. C. Blackall, T. A. Bissell and Angus Sinclair are a Committee of Arrangements for this Convention.

NOTES AND NEWS.

Austrian Ties and Track.—The illustration herewith shows two sections of track on the Emperor Ferdinand Northern Railroad of Austria, that given in fig. 1 being laid on Bessemer steel ties of the Heindl pattern, and that in fig. 2 on oak ties treated by the chlorate of zinc process. The rails weigh 71 lbs. to the yard. The engravings show the spacing of ties, arrangement of joints, etc., the figures given being in meters.

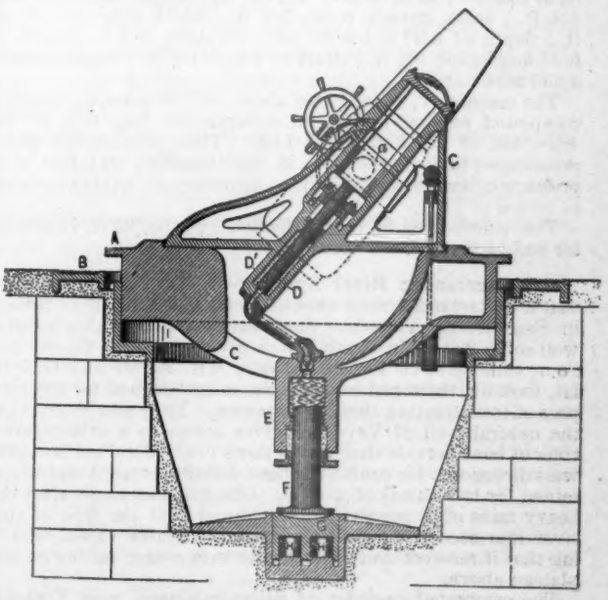


PLANS OF TRACK, EMPEROR FERDINAND NORTHERN RAILROAD.

Some account of a test of the steel ties was given in our January number. The Heindl metallic tie is now used for all renewals on this road.

The Morgan Mortar Mounting.—The accompanying illustration shows a mount for mortars, designed by Mr. William H. Morgan, of the Morgan Engineering Works, Alliance, O., which is intended to be especially an improvement on those mountings having hydraulic cylinders so arranged that the recoil of the gun forces fluid contained in the cylinders carried by the carriage down into a cylinder below the carriage, whereby the carriage is elevated and the energy of the recoil stored for elevating the gun. As water is practically incompressible, it will not yield to pressure when properly housed, and hence may prove too rigid and unyielding under the first shock of the recoil. The object of the new design is to provide means adapted to yield under the first shock of the recoil and before the weights begin to move.

The carriage *A* normally rests on a flange of the ring *B* and is provided with castings *C*, having inclined sideways in which the boxes *a*, carrying the trunnions of the gun, move. The boxes are connected to the upper ends of plungers, *D*, which move in hydraulic cylinders *D'*, carried by the carriage. These cylinders are connected by pipes with a cylinder, *E*, located below the carriage, and the water or other fluid, as it is acted upon by the movement of the plungers caused by the recoil of the gun, is forced from the cylinders on the carriage into the cylinder under the carriage, and there, acting on a plunger, *F*, operates to elevate the carriage. Now, by opening communication between the lower cylinder and the upper cylinders the weight of the carriage will expel the liquid from the lower cylinder and force it into the upper cylinders, thereby permitting the carriage to descend to its normal position and elevating the gun to its firing position. In the drawing the plunger *F* is shown mounted on a block, *G*, seated in the base plate and supported on a series of springs, *H*. The upper end of the plunger rests in the cylinder *E*, and hence it follows that the fluid as it first enters the cylinder *E* will act on the springs and compress them, thus allowing time for the weight (carriage and gun) to begin to move. The plunger is in effect a spring plunger, one end being yieldingly supported and the other end adapted to receive the impact of the fluid forced into the lower cylinder from the upper cylinder. This finid is under powerful pressure, and as soon as the upper plungers carrying the gun begin to move under the recoil the water in the upper



THE MORGAN MORTAR MOUNTING.

cylinders and in the pipes between the upper and lower cylinders is put in motion, and as the fluid in the lower cylinder is under the same pressure as the fluid in the upper cylinders, it follows that the instant fluid is displaced in the upper cylin-

ders an increased space in the lower cylinder must be provided for such displaced fluid. By means of springs yieldingly supporting the plunger the latter is permitted to descend and thus provide space for the fluid forced into the cylinder. This takes the shock off the carriage, and the latter is thus given time to recover and begin to ascend gradually in comparison to what its movements would be were the plunger rigid.—*Iron Age.*

Transmission of Power by Electricity.—In Italy, where there are numerous small water powers, the Italian Electrical Society is making many applications of electric transmission. From the Gravellone waterfall near Padua 200 H.P. are carried half a mile; the Alzano waterfall is used to distribute 180 H.P. at one-third of a mile, 40 H.P. at half a mile and 50 H.P. at three miles. A plant is now under construction to transmit 1,000 H.P. from the Cassagno falls to Intra, a distance of six miles.

A Large Gas-holder.—San Francisco has a claim for modesty in respect to various works carried out here in a quiet manner, that would call for much more noise and ink in other places. The gas company, for example, have erected, on the north side of the city, a gas-tank of unusual dimensions that very few people have heard of. It is to hold 2,000,000 cub. ft., is 168 ft. in diameter, and the total height 145 ft. The excavations are 37 ft. deep. The floor coating is 24 in. thick, of stone and concrete. The walls are 8 ft. thick. The iron work was done by the Union Iron Works, and the material furnished here, mainly by the Pacific Rolling Mills Company. The cost of the whole is about $250,000. This is, except some gas-holders at New York and one in Chicago, the largest in this country, and goes to show the fact that electric lighting does not interfere greatly with the consumption of gas.—*Industry, San Francisco.*

A New Sound Steamer.—The construction of the new passenger steamboat for the Fall River Line is now fairly begun at the Roach shipyards, in Chester, Pa., and the vessel promises to be one of the finest specimens of marine architecture and building thus far produced.

The new boat is to be larger, of greater carrying capacity as regards both passengers and freight, and will be even more elaborately finished and furnished than the *Puritan* of the same line, although the *Puritan* now stands first of all vessels of her class afloat. The principal points of difference between the boat now building and the *Puritan* are: the new boat will be at least 20 ft. longer than the last-named; she will have double inclined compound engines, instead of compound beam engines; she will have boilers of the Scotch instead of the Redfield type and her dining saloon will be on the main deck.

The dimensions and proportions of the new steamboat will be as follows: Length over all, 440 ft.; length on water-line, 424 ft.; beam, outside plate, 52½ ft.; width over guards, 93 ft.; depth of hold at lowest point of sheer, 20½ ft.; depth of hold amidships, 21½ ft.; draft of water, 12½ ft.; displacement, 4,550 tons.

The machinery, as indicated above, will be a double inclined compound engine, in general arrangement like that of the *Plymouth*, of the Fall River Line. There will be two high-pressure cylinders, each 51 in. in diameter; and two low-pressure cylinders, each 95 in. in diameter, all having a stroke of piston of 11 ft.

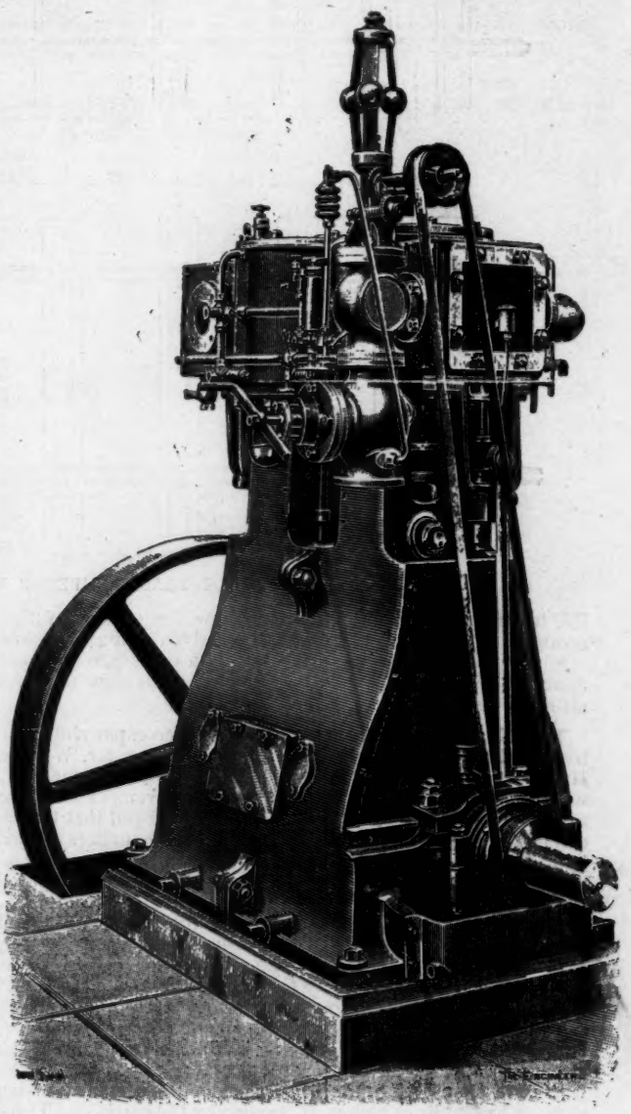
The wheels will be of the feathering type, 35 ft. in diameter and 14 ft. face.

A Subterranean River System.—It has long been known that a subterranean river existed in the Aveyron, near Rodez, in France. At Veyssiere there exists a remarkable natural well some 200 ft. in depth which gives access to the stream. Some time ago two French savants, MM. Martel and Gaupillat, took up their residence in the neighborhood for the purpose of investigating these phenomena. They now report that the natural well of Veyssiere gives access to a subterranean river of considerable size, which flows in a general north-northwest direction. Its course has been definitely traced and determined for two-thirds of a mile. Observations made after the heavy rains of September, 1892, showed that the flow of this river increased suddenly to a very considerable extent, showing that it receives and collects the rain water falling on the plateau above.

The celebrated cascades of Salles-la-Source, near Tindoul, are evidently fed by this subterranean river. Starting from that point the explorers succeeded in ascending the stream underground for nearly 1,000 ft. They then discovered the existence of a great basin serving as a reservoir for the cascades or springs of Salles—which never dry up and vary in flow very little—and spreading out in time of floods into other galleries or caverns which serve to hold the overflow. These caves form an underground storage reservoir of a very curious nature; no other similar one has been explored, though some are supposed to exist in our own country.

An English Vertical High-Speed Engine.—The illustration given, from the London *Engineer*, shows a type of vertical high-speed engine adopted by Robey & Company, of Lincoln, who are extensive builders of stationary engines. It is of interest as showing a pattern popular in that country, as it does not differ materially from those of other builders.

These engines are principally used for electric lighting, although some of them have been very successfully applied for working high-speed shafting direct for saw-mills and other industries. The engine shown is one of the small sizes, and has a high-pressure cylinder 8½ in. diameter, low-pressure 14¼ in. diameter by 10 in. stroke, and runs easily and quietly up to 300 revolutions per minute, developing at that speed up to 75 H.P. The larger sizes are made with automatic gear and balanced piston valves. It will be seen all the working parts are enclosed, and the connecting-rod big end runs in a shallow bath of oil; the moving parts are by this means perfectly lubricated. The bearings are exceptionally large, and all the working parts have great strength and ample surfaces. While not competing in economy with long-stroke trip-gear engines, yet these engines are nevertheless worked with a very small consumption of steam, and are constructed for very long continuous runs, and they are frequently combined on one bedplate with a dynamo, to which they are coupled direct.



AN ENGLISH VERTICAL HIGH-SPEED ENGINE.